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Aggregate and Soil
Proficiency Samples 2001

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Aggregate and Soil Proficiency Samples 2001

Authors:	M. Vasavithasan, C.A. Rogers
Abstract:	The Materials Engineering and Research Office, Soils and Aggregates Section, runs a proficiency sample testing program each year to provide a means for participating laboratories to see if they are performing satisfactorily. The laboratories are asked to perform a number of different tests on pairs of samples that have been prepared and randomly selected at the MTO Laboratory. The samples are delivered to the participating public and private sector laboratories, starting in June. The laboratories report their results starting in August. A preliminary report, issued in mid September, gives feedback to the participants while they are still operational in the current year. This allows them to examine their procedures or equipment and correct any problems that may have occurred. A final report is issued after analysis of the data has been completed. This is the final report for the Aggregate and Soil Proficiency Samples for 2001. This year there were two hundred and eleven laboratories participating from the private sector, various municipalities and other provincial governments. Results of the 2001 Proficiency Sample Program show noticeable improvements compared to previous years' results. Particularly, the results of sieve analyses, wash pass 75-µm, Los Angeles abrasion, relative density and absorption, percent crushed particles, petrographic number, one-point proctor and Micro-Deval (fine) show improvements over previous years'. This is likely due, in part, to laboratory improvements brought about by the Canadian Council of Independent Laboratories (CCIL) inspection program of Aggregate Laboratories. Although there is noticeable improvement in results, strong laboratory biases still remain in a majority of the test procedures. The number of laboratories participating in soil tests in 2001 has increased substantially compared to previous years. The results of all the soil tests show marked improvements over previous years'. This year, we continued with our rating system for laboratories. The rating system has acted as an incentive for laboratories to improve their performance. In an effort to improve soil testing laboratory performance, a laboratory inspection process conducted by MTO began in September 1999.
Keywords:	Aggregate, correlation, laboratory, proficiency testing, soil, testing
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MTO

Aggregate and Soil

Proficiency Samples

2001

Prepared by:

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Soils and Aggregates Section

Materials Engineering and Research Office

Ministry of Transportation, Ontario

March, 2002

This report is published without prejudice as to the application of the findings.

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MTO AGGREGATE AND SOIL PROFICIENCY SAMPLES 2001

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Executive Summary

The Soils and Aggregates Section of the Materials Engineering and Research Office, runs an annual proficiency sample testing program for aggregate and soil tests. This provides a means for participating laboratories to see if they are performing satisfactorily. The laboratories are asked to perform a number of different tests on pairs of samples that have been prepared and randomly selected by the Soils and Aggregates Laboratory. The samples are delivered to the participating laboratories starting in June. The laboratories report their results starting in August. A preliminary report issued in mid September, gives feedback to the participants while they are still operational in the current year. This allows them to examine their procedures or equipment and correct any problems that may have occurred. A final report is issued after analysis of the data has been completed.

This is the final report for the 2001 MTO Aggregate and Soil Proficiency Sample Testing Program. This year there were two hundred and eleven (211) laboratories participating from the private and public sector. Of these, one hundred and forty-four were aggregate producer's and road builder's Quality Control (QC) Laboratories. Participation in this program is required by the contract documents if their QC process is to be acceptable to MTO. In general, these laboratories are conducting particle size analysis, wash pass 75 μm, percent crushed particles, percent asphalt coated particles, and density tests for granular base and sub-base aggregates.

Reports to individual laboratories contain ratings for each test method, which are based on the standardized deviate for that test (*i.e.* a rating of 5 for data within 1.0 standard deviation of the mean, a rating of 0 for data 3.0 or more standard deviations from the mean). Ratings for each test method are also used to calculate an overall laboratory rating. This rating system has acted as an incentive for laboratories to improve their performance.

Results of the 2001 Proficiency Sample Program show noticeable improvements compared to previous years' results. Particularly, the results of sieve analyses, wash pass 75-μm, Los Angeles abrasion, relative density and absorption, percent crushed particles, petrographic number, one-point proctor and Micro-Deval (fine) show improvements over previous years'. This is likely due, in part, to laboratory improvements brought about by the Canadian Council of Independent Laboratories (CCIL) inspection program of Aggregate Laboratories. Although there is noticeable improvement in results, strong laboratory biases still remain in a majority of the test procedures. The number of laboratories participated in soil tests in 2001 have increased substantially compared to previous years. The results of all the soil tests show marked improvements over previous years.

Since September 1999, Soils and Aggregates Section has been inspecting soil testing laboratories in an effort to improve quality of testing services provided to MTO. This inspection is being done only at the request of laboratories. To date, thirty-three laboratories have been inspected, of which twenty-four laboratories have already addressed the deficiencies that were identified.

REPORT FOR
MTO AGGREGATE AND SOIL PROFICIENCY SAMPLES 2001

1.0 INTRODUCTION

This is the final report of an inter-laboratory testing program organised by MTO for aggregate and soil test methods. It is primarily intended to provide a means for the MTO Laboratory and other laboratories used by MTO to see if they are performing satisfactorily and to qualify these laboratories to perform quality control and quality assurance testing for MTO contracts[1]. The design of the testing program is based on procedures for determining the precision and variability of test methods. Interested parties should refer to ASTM C670[2], C802[3], E177[4] and E178[5] for further information on inter-laboratory testing programs.

There were a total of two hundred and eleven laboratories participating in this study, conducted in the summer of 2001. This included the MTO laboratory, the remainder being from the private sector, municipalities and other provincial governments. Samples were delivered to laboratories in June and July. A preliminary report was issued in mid September.

1.1 Table of Test Results

Each participant receives an individual summary of results for their laboratory. An example of a typical report is shown in Tables 1, 2, and 3. Each Table of Results identifies the laboratory by number and compares the laboratory's data with the means obtained after statistical analysis of the data received from all laboratories. The identity of the laboratories is kept confidential.

Column 1 gives the test method as designated in the MTO Laboratory Testing Manual.

Columns 2 and 3 show the test data submitted by the laboratory for a pair of samples. (Note - when valid data is reported for only one of the samples in the pair, the test data is excluded from the statistical analysis and does not appear on the table of results).

Columns 4 and 5 show the mean (average) test value for each sample, for all laboratories performing the test, after removal of outliers and/or invalid test data.

Columns 6 and 7 list the standardized deviate for each test result. The standardized deviate is used to show how the individual test results compare to the mean. It is obtained by subtracting the mean of all data ($\bar{x}$) from the actual test result reported by the laboratory (χ_i) and dividing by the standard deviation (s). That is:

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[1] Laboratories must also be inspected and recognised by the Canadian Council of Independent Laboratories (CCIL).
[2] ASTM C670 Practice for Preparing Precision and Bias Statements for Test Methods of Construction Materials.
[3] ASTM C802 Practice for Conducting an Inter-laboratory Test Program to Determine the Precision of Test Methods of Construction Materials.
[4] ASTM E177 Practice for Use of Terms Precision and Bias in ASTM Test Methods.
[5] ASTM E178 Practice for Dealing with Outlying Observations.

Table 1. Summary of Results (Laboratory 47)

TEST RESULTS FOR LABORATORY NUMBER 47			DATE PREPARED: Feb. 14, 2002					
COARSE AGGREGATE REFERENCE SAMPLES 1.01 2.01								
TEST METHOD	LABORATORY DATA		MEAN OF LABORATORIES		STANDARDIZED DEVIATE		LAB RATING	
	1.01	2.01	1	2	1	2	1	2
LS-601 WASH PASS 75 µm (CA)	0.890	0.890	0.856	0.903	0.149	-0.125	5	-5
LS-602 % PASS 19.0 mm (CA) % PASS 16.0 mm (CA) % PASS 13.2 mm (CA) % PASS 9.5 mm (CA) % PASS 4.75 mm (CA)	94.400 85.900 77.300 65.200 48.650	93.800 85.500 77.700 65.800 49.250	94.071 86.263 79.156 67.268 51.113	94.140 86.456 79.405 67.424 51.168	0.304 -0.287 -1.171 -1.297 -1.654	-0.334 -0.808 -1.267 -1.168 -1.355	5 -5 -4 -4 -3	-5 -5 -4 -4 -4
LS-603 LOS ANGELES ABRASION %	26.200	26.100	24.682	24.918	1.067	0.934	4	5
LS-604 DR (CA-BULK S.S.D.) ABSORPTION (CA)	2.692 1.530	2.692 1.590	2.686 1.645	2.684 1.662	0.771 -1.285	1.047 -0.945	5 -4	4 -5
LS-606 MGSO4 % LOSS (CA-MTO)	5.000	4.000	5.057	5.145	-0.030	-0.597	-5	-5
LS-607 % CRUSHED PARTICLES	65.000	67.000	60.047	59.741	1.082	1.468	4	4
LS-608 % F & E PARTICLES	1.000	2.000	3.347	3.489	-1.172	-0.744	-4	-5
LS-609 PN (CONCRETE)	107.40	113.70	110.71	110.31	-0.481	0.572	-5	5
LS-618 MICRO DEV ABS (CA)	6.500	6.200	6.603	6.536	-0.236	-0.727	-5	-5
LS-614 FREEZE THAW, %	4.000	4.000	5.647	5.837	-1.077	-1.247	-4	-4

Blank spaces represent not tested.
* - calculation considered outlier

Table 2. Summary of Results (Laboratory 47)

TEST RESULTS FOR LABORATORY NUMBER 47 DATE PREPARED: Feb.14, 2002

FINE AGGREGATE REFERENCE SAMPLES 3.01 4.01

TEST METHOD	LABORATORY DATA		MEAN OF LABORATORIES		STANDARDIZED DEVIATE		LAB RATING	
	3.01	4.01	3	4	3	4	3	4
LS-602								
% PASS 2.36 mm (FA)	39.800	41.900	41.785	41.964	-1.291	-0.020	-4	-5
% PASS 1.18 mm (FA)	32.300	34.700	34.084	34.283	-1.018	0.237	-4	5
% PASS 600 µm (FA)	24.100	25.700	25.410	25.628	-0.779	0.058	-5	5
% PASS 300 µm (FA)	13.700	14.700	14.037	14.218	-0.353	0.483	-5	3
% PASS 150 µm (FA)	7.500	8.200	7.712	7.811	-0.447	0.699	-5	5
% PASS 75 µm (FA)	5.120	5.610	5.304	5.372	-0.487	0.621	-5	5
LS-605								
DR (FA-BULK S.S.D.)	2.663	2.666	2.654	2.652	0.696	0.962	5	5
ABSORPTION (FA)	0.730	0.690	0.762	0.782	-0.222	-0.506	-5	-5
LS-606								
MGSO4 % LOSS (FA)	9.000	9.000	8.298	8.303	0.202	0.114	5	5
LS-621								
ASPH COATED PARTICLES	30.800	33.900	29.867	29.788	0.349	1.365	5	4
LS-706								
MAX WET DENSITY g/cm^3	2.272	2.255	2.248	2.249	0.807	0.224	5	5
MAX DRY DENSITY g/cm^3	2.090	2.071	2.066	2.066	0.865	0.165	5	5
OPTIMUM MOISTUR, %	8.700	8.900	8.889	8.877	-0.345	0.083	-5	5
LS-619								
MICRO DEV ABS (FA)	11.400	11.300	11.148	11.127	0.261	0.184	5	5

Blank spaces represent not tested.
* - calculation considered outlier

Table 3. Summary of Results (Laboratory 47)

TEST RESULTS FOR LABORATORY NUMBER 47 — DATE PREPARED: Feb. 14, 2002

SOILS REFERENCE SAMPLES 5.01 6.01

TEST METHOD	LABORATORY DATA		MEAN OF LABORATORIES		STANDARDIZED DEVIATE		LAB RATING	
	5.01	6.01	5	6	5	6	5	6
LS-702								
% PASS 2.00 mm (SOIL)	99.900	100.00	99.959	99.967	-0.616	0.537	-5	5
% PASS 425 µm (SOIL)	96.100	96.300	96.338	96.338	-0.717	0.119	-5	5
% PASS 75 µm (SOIL)	88.800	88.600	88.647	88.713	0.331	-0.267	5	-5
% PASS 20 µm (SOIL)	69.800	68.100	69.609	69.808	0.000	-0.474	5	-5
% PASS 5 µm (SOIL)	45.000	45.200	43.863	44.020	0.260	0.405	5	5
% PASS 2 µm (SOIL)	30.000	28.300	30.882	30.880	-0.328	-0.722	-5	-5
LS-707								
LIQUID LIMIT, %	29.200	29.100	27.354	27.343	1.562	1.481	3	4
LS-704								
PLASTIC LIMIT, %	16.000	16.100	15.271	15.413	0.721	0.664	5	5
PLASTICITY INDEX, %	13.200	13.000	12.185	12.091	0.599	0.476	5	5
LS-705								
RELATIVE DENSITY	2.791	2.778	2.720	2.725	2.714	2.155	1	2
LS-706								
MAX WET DENSITY g/cm³								
MAX DRY DENSITY g/cm³								
OPTIMUM MOISTUR, %								

Blank spaces represent not tested.
* - calculation considered outlier

$$\text{Standardized deviate} = \frac{x_i - \bar{x}}{s}$$

If the test result is smaller than the mean, the standardized deviate is negative, and if the test result is greater than the mean, the standardized deviate is positive. In brief, the standardized deviate tells us how many standard deviations the test result is away from the mean.

Columns 8 and 9 list the test method ratings, which are similar to the standardized deviate, but are in a simple numeric form. Ratings are determined as follows:

Rating 5 - data within 1.0 standard deviation of the mean.
Rating 4 - data within 1.5 standard deviations of the mean.
Rating 3 - data within 2.0 standard deviations of the mean.
Rating 2 - data within 2.5 standard deviations of the mean.
Rating 1 - data within 3.0 standard deviations of the mean.
Rating 0 - data 3.0 or more standard deviations from the mean or data considered to be outlying by other methods.

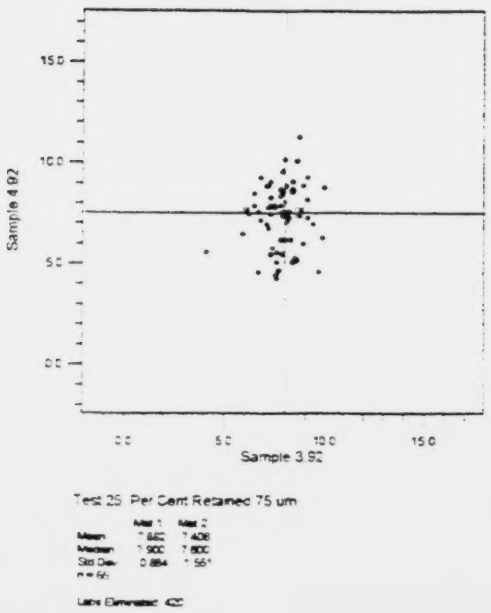
A negative sign simply indicates a result that is smaller than the mean. If one of the paired test results for a given test is excluded based on the outlier criteria, the other test result is still subjected to the statistical analysis and is only excluded if it also fails to meet the criteria.

Significance need not necessarily be attached to a single low rating. However, a continuing tendency to get low ratings on several pairs of samples or on a series of tests from one procedure, *e.g.* sieve analysis, should lead a laboratory to re-examine its equipment and test procedure. A laboratory that reports data for a specific test consistently lower or higher than the mean over a number of test periods also needs to re-examine their test procedure, because this is evidence of a systematic bias in how the laboratory conducts the procedure. Any computer program that is used by a laboratory to calculate test results should be verified as part of this examination.

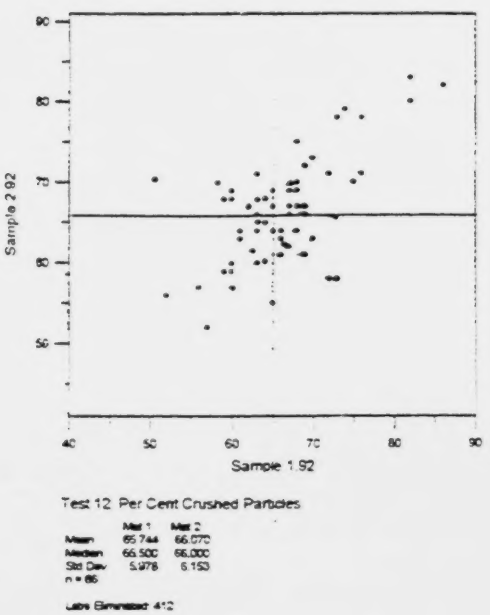
1.2 Scatter Diagrams

Youden scatter diagrams are supplied with this report (see appendix). A laboratory can locate itself on the diagrams by plotting its test value for the first sample (1.01) on the horizontal axis, against its test value for the second sample (2.01) on the vertical axis. The horizontal and vertical axes are of equal length and are scaled to give the most informative display of the plotted points. In some cases, this results in outlying points plotting off the diagram. If the results from two or more laboratories happen to coincide, a single point is plotted.

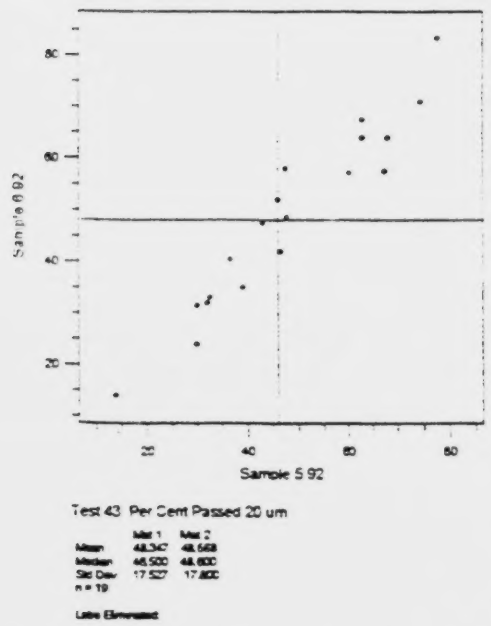
Below each scatter diagram, the test number and title are given, followed by a table of statistical calculations for both samples. Here the mean, median and standard deviation for each sample are given. The number of laboratories reporting valid data and the laboratories eliminated by statistical analysis are also listed.



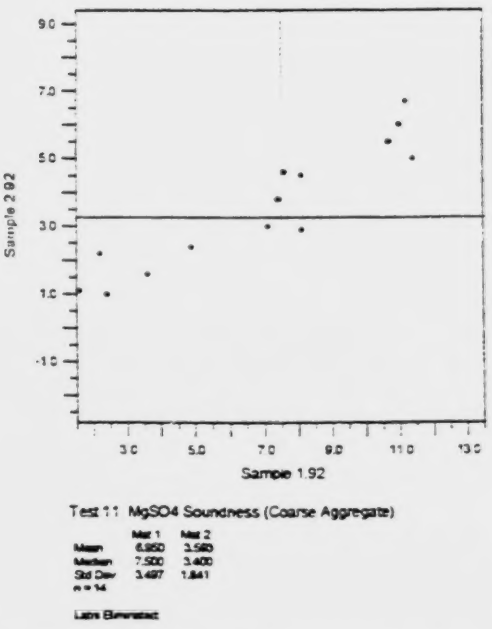
Scatter diagram for a test showing random variation with little laboratory bias



Scatter diagram for a test showing a combination of random variation and laboratory bias for some laboratories



Scatter diagram for a test showing pronounced between laboratory bias and equal variation for each material



Scatter diagram for a test with pronounced between laboratory bias but unequal variation for each material

Figure 1: Examples of Scatter Diagrams

The vertical and horizontal cross-hairs on the plots represent the mean values for all the results on the first sample (1.01) and the second sample (2.01) respectively. These lines divide the diagram into four quadrants, numbered 1 through 4, beginning in the upper right-hand quadrant and continuing clockwise. In an ideal situation where only random errors occur, the points are expected to be equally numerous in all quadrants and will form a circular distribution. This follows because plus and minus errors should be equally likely. Often, however, the points tend to concentrate in quadrants 1 and 3 on the diagram. This occurs because laboratories tend to get high or low results on both samples. This gives evidence of individual laboratory biases. As the tendency to laboratory bias increases, the departure from the expected circular distribution of points towards a linear distribution from quadrant 1 to 3 occurs. Such a distribution of points indicates systematic variation. Figure 1 gives examples of scatter diagrams.

1.3 Outliers

In dealing with suspected outlying observations or 'outliers', our purpose is to remove those observations that do not belong to the sample population and to provide some statistical criteria for doing so. There are a number of ways to do this. In most of these, as ASTM E178 states, 'the doubtful observation is included in the calculation of the numerical criterion (or statistic), which is then compared with a critical value based on the theory of random sampling to determine whether the doubtful observation is to be retained or rejected. The critical value is that value of the sample criterion that would be exceeded by chance with some specified (small) probability on the assumption that all observations did indeed constitute a random sample from a common system of causes, a single parent population, distribution or universe.'

The MTO study follows the criteria recommended for single samples in Section 4 of ASTM E 178 for rejecting the doubtful observations at the ninety-nine percent confidence level. The assumption in this method is that all the observations come from the same normal population. The doubtful observation is included in the calculation of mean and standard deviation of the population. Then the critical value, T_n, for that observation, n, in question is calculated and compared with the critical value based on the theory of random sampling. The doubtful observation is rejected if T_n is higher than the critical value for the one percent significance level. The iterations are continued until no outlier is identified, and a revised mean and standard deviation are calculated after deleting the outliers. This method is identified as three standard deviation technique in the report.

We are in some cases handicapped due to a low number of laboratories participating in some tests, when the strict application of the three standard deviation criteria tends to include laboratories in the population who are not doing a good job. In these cases, the application of the iterative (jack-knife) technique recommended by Manchester[9] is used. In this method, the significance level depends on the number of laboratories participated, and the level of significance will be between 1 % and 2.5 %.

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[9] EM-33, The Development of an Interlaboratory Testing Program for Construction Aggregates, by L. Manchester, Ministry of Transportation, Ontario, Engineering Materials Office, Downsview, December, 1979.

2.0 DISCUSSION

The following discussion contains general and test-specific comments for the 2001 test period. Where ASTM precision statements are published for a given test, an attempt has been made to compare these with the statistics for this period.

A discussion of statistical techniques is presented in the Glossary of Terms, found in an appendix.

2.1 Notes on Material Sources

Materials used in this test period were as follows:

- Coarse and fine aggregate tests, including Sieve Analysis, Percent Crushed Particles (CA), Relative Density and Absorption (FA), Moisture Density Relationship, Micro-Deval Abrasion Loss (FA), Los Angeles Abrasion (CA), and Magnesium Sulphate Soundness (FA) – Granular 'A' from Coppins Corner Pit (MTO MAIDB No. NO2-124, Vicdom Sand & Gravel (Ontario) Limited).
- Coarse Aggregate tests, including Wash Pass 75 µm, Percent Flat and Elongated Particles, Relative Density and Absorption, Magnesium Sulphate Soundness, Petrographic Analysis, Micro-Deval Abrasion Loss, and Freeze - Thaw - HL8 Stone from Cayuga Materials & Construction Company Limited, Cayuga Quarry (MTO MAIDB No. D05-020).
- Fine Aggregate Petrographic Examination – Concrete sand from Erie Sand & Gravel, Leamington Pit (MTO MAIDB No. E02-020).
- Soil tests – Clayey soil from "Huron Slope" Physiographic Region located near Parkhill in West Williams Township.

2.2 Notes on Sample Preparation

The material processed for the aggregate tests conforms approximately to a granular 'A' gradation. The aggregate samples were prepared using a large spinning riffler, developed and built by staff at the MTO Downsview Laboratory (refer to Figures 2 and 3 of Report MI-179, dated February 2000). Twenty-five tonnes of granular 'A' were placed in layers into five separate stockpiles. A bobcat loader was used to fill an aggregate bin with small scoops from each stockpile in turn, in order to minimize sample bias. Material was fed along a conveyor belt to fill 30 identical buckets on a spinning turntable. It was found that 18 to 20 revolutions of the turntable were required to fill each bucket to approximately 28 Kg. This resulted in more homogeneity of the samples than would normally be the case using other techniques. In total, five hundred 28 Kg samples were prepared and randomised for distribution to participating laboratories. The participants were responsible for the preparation of their own fine aggregate samples (3.01 and 4.01) from the two bags of granular 'A' delivered.

The material for the soil tests was air dried over a period of six weeks, powdered past 2.0 mm using a Fritsch Soil Mill Pulverizer, and placed in 50 buckets. Individual scoops from each bucket were then placed in the hopper of a small spinning riffle splitter, which filled 24 identical 2 Kg containers per run. This method was used to create 50 uniform buckets. The 500 g correlation materials were obtained from splitting samples from these buckets in the spinning riffler and then randomising for distribution to participating laboratories. This use of a spinning riffler ensured that as far as possible, each sample was identical to every other sample. It has been found that this is the best technique for minimising sample bias.

2.3 Notes on Individual Tests

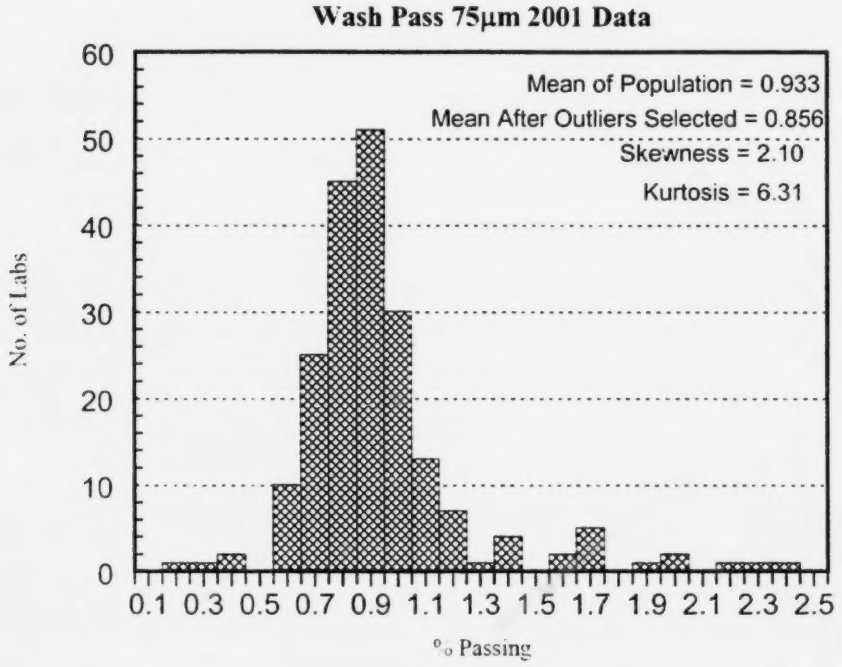
For each test, comments have been made pertaining to the variation illustrated by the scatter diagram. The technique used to test for outliers is stated and where possible, reasons for the outlying observations are offered. It is important to keep in mind that there are many variables influencing laboratory testing.

A summary of the statistical data is presented in the Multi-Laboratory Precision Tables, found in the appendix. Besides the comparison made to ASTM precision statements, comparison of the variation between test periods is made for each of the tests. Because the materials usually differ from year to year, it is emphasised that the comparison between years should be used only as a guide. It is important to note that the yearly use of different materials will have some effect on the variation exhibited in some tests, while it will have relatively little effect on others. For example, the magnesium sulphate soundness test exhibits reduced variation as lower mean loss is reported. A coarse aggregate sample having an average mean loss of twenty percent would likely show more variation than a coarse aggregate sample having an average mean loss of ten percent. On the other hand, a sieve analysis could be performed on those same two aggregates, with the percent passing each sieve and the variation being remarkably similar for the two samples.

2.3.1 Wash Pass 75 µm (Coarse Aggregate) - Test No. 1

Two hundred and four laboratories participated in this test. Thirty-five outliers were identified and rejected using the three standard deviation technique. The standard deviation is significantly less than in previous years and also less than the value published by ASTM. The scatter diagram shows random variation with noticeable laboratory bias. However, a considerable number of laboratories (35) compared to previous years, have been identified as outliers.

In view of the large number of outliers, the data was further examined by comparing with 2000 data. The distribution of data from 2000 and 2001 programs are plotted in Figure 2 in the form of a histogram. Kurtosis measures the flatness or sharpness of the distribution peak, and is compared with the expectation of 3.0 derived from the "normal distribution" model. A kurtosis value of 6.31 for 2001 data compared to a value of 1.3 for 2000 data, suggests that most of the laboratories in 2001 have reported



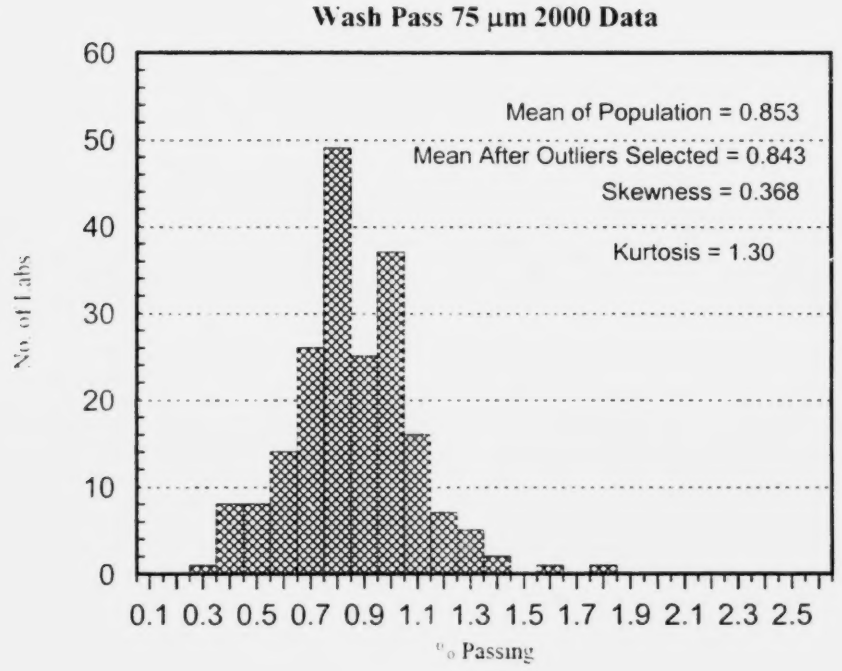


Figure 2 - Distribution of Wash Pass 75 µm Data

results closer to the mean than in previous years. The skewness coefficient of 2.1 yielded by 2001 data also indicates asymmetry of data about its mean with a positive tail longer to the right. The longer tail and sharpness of the data distribution have resulted in a large number of outliers. The laboratories that are identified as outliers must examine their test procedure more closely.

2.3.2 Sieve Analysis (Coarse Aggregate) - Test Nos. 2-6

These tests represent the coarse aggregate portion of the sample gradation. Tests 20-25, carried out on the material passing 4.75 mm as prepared by the participants (samples 3.01 and 4.01), represent the remainder of the gradation. The data is presented in percent passing format and is compared to precision statements developed in the same format by Vogler and Spellenberg[7].

The samples were prepared with a large spinning riffler that is described in Section 2.2. This method of preparation minimises the sample variation and has resulted in no observable gradation difference between samples 1.01 and 2.01. The variations found in 2001 are similar or comparable to that of 2000 and also significantly less than the expected variation given in the ASTM precision statements.

Two hundred and eight labs carried out the sieve analysis test. Outliers were eliminated using the three standard deviation technique. Successive scatter diagrams show a fairly uniform distribution of points about the mean and only four to eight laboratories had reported results that deviated considerably from the mean.

Possible reasons for outlying observations include factors that impact the measurement process such as sieve condition (state of repair and cleanliness), efficiency of the sieving process and apparatus, initial sample mass, and mass on a given sieve. If your laboratory has performed poorly in this test period, you should inspect your sieves (use CAN/CGSB-8.1-88 or ASTM E-11 as guides) and your sieve shaker(s) thoroughly, and once satisfied that they are in order, perform a sieving efficiency test (MTO Method LS-602, Note 2) to pinpoint any problems.

2.3.3 Los Angeles Abrasion Loss (Coarse Aggregate) Test No. 8

Only twelve laboratories participated in this test. One outlier was eliminated using the iterative technique. The lower left and upper right quadrants together account for ten of the twelve points, which is evidence of strong laboratory biases. This test shows systematic variation, as was found in previous years, however, the variation is significantly less than in previous years. ASTM precision statements for 19.0 mm maximum size coarse aggregate, with percent loss in the range 10 to 45%, give a multi-laboratory coefficient of variation of 4.5%. Therefore, results from two different laboratories should not differ by more than 12.7%. The mean in this test (24.8%) is in the range of values for which ASTM data was established, and comparison indicates that this year's variation is comparable to that of ASTM precision statements.

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[7] Vogler, R.H., Department of Transportation, Michigan, AASHTO Technical Section 1c; T27 and Spellenberg, P.A., AASHTO Materials Reference Laboratory; Unpublished Paper

2.3.4 Relative Density (Coarse Aggregate) - Test No. 9 and Absorption (Coarse Aggregate) - Test No. 10

Eighty-nine laboratories participated in these tests this year. Ten laboratories in the Test No. 9 and seven laboratories in Test No. 10 were eliminated using the three standard deviation technique. The variation for each of these tests is significantly less than in previous years, and considerably less than the values given in the ASTM precision statements. However, the number of laboratories identified as outliers are considerably higher than in previous years. It is noteworthy that precision has improved markedly compared with values obtained in 1997, prior to implementation of a Province-wide laboratory inspection and certification program. In addition, the scatter diagrams show a fairly uniform distribution of points about the mean indicating random variation with some laboratory bias.

2.3.5 Magnesium Sulphate Soundness (Coarse Aggregate) Test No. 11

Forty-one laboratories performed this test in 2001, and one outlier was selected using the iteration technique. The scatter diagram shows a strong laboratory bias and all the points, with the exception of two, are accounted in the lower left and upper right quadrants. This test has historically shown high coefficients of variation due to the difficulty of maintaining solution of the correct density and insufficient drying by some laboratories. The coefficient of variation in 2001 (37.6%) is slightly higher than in previous three years (30.8% to 32.6%). The coefficient of variation is also higher than that of ASTM precision statements, which report a coefficient of variation of 25% for the percent loss range of 9 to 20.

2.3.6 Percent Crushed Particles - Test No. 12 and Percent Cemented Particles - Test No. 7

Two hundred and three laboratories performed the percent crushed particles test this year. Twenty-six outliers were selected by the three standard deviation technique. The number of outliers identified this year is considerably higher than in previous years. This may be due to misinterpretation of the test method or instructions provided. Variation is noticeably less than the values obtained during 1989 MTO workshop[8]. The mean in this test (59.8) is within the range of values (50 to 75) for which MTO data was established. The sample sent did not contain any cemented particles; therefore the percent cemented particles test was not evaluated this year. ASTM has a test method (D 5821) but has not conducted inter-laboratory studies to determine precision.

2.3.7 Percent Flat and Elongated Particles - Test No. 13

The determination of a flat and/or elongated particle is dependent on operator skill and judgement in using the measurement tool. The ASTM and CSA procedures use a

[8] MI-134, Determination of Crushed Particles for Test Method LS-607, by Price, Gage and Junor, Ministry of Transportation, Ontario, Engineering Materials Office, Downsview, March 1989, ISBN-0-7729-5558-1.

proportional calliper device to measure the *greatest* length or width to thickness ratio. The MTO procedure previously measured the *mean* length or width to the *mean* thickness (MTO Laboratory Manual Revision 15 and earlier). The MTO procedure (Revision 16 and up) has been modified to agree with the ASTM definition. All participants should be using the latest MTO version of the test.

One hundred and fifty five laboratories reported test results this year. The iteration technique was used to reject thirteen outliers. The number of outliers is comparable to the numbers in previous years. The standard deviation is lower than in previous years but the amount of flat and elongated particles was also low compared to previous years, so the lower standard deviation does not necessarily indicate an improvement in overall performance. ASTM and CSA do not report precision for this test.

2.3.8 Petrographic Number (Concrete) - Test No. 14

Analysts from thirty-two laboratories examined samples 1.01 and 2.01 (full fraction), and submitted work sheets showing subdivision according to rock type and quality. Laboratories 13, 80, 84, and 196 used the same analyst, as did 101 and 203. Laboratories 39, 112, and 172 used outdated work sheets. Laboratory 175 mistakenly recorded hard carbonate and soft/slightly shaley carbonate as trap. The results are shown in the appendix and were evaluated by D.A. Williams, MTO Petrographer.

The samples contained approximately 95% good aggregate (approximately 85% hard carbonate and 10% medium hard carbonate). A value of good aggregate content of less than 85% was reported by Laboratory 22 (1.01 only). Most of the hard carbonate content was reported as medium hard carbonate by Laboratories 35 and 295. Laboratories 71 (2.01 only), 100, and 175 reported hard or medium hard sandy carbonate contents of 27.8% or greater. Laboratory 72 reported 19.4% slightly cherty carbonate for sample 1.01. Laboratory 19 reported 86.8% hard or medium hard conglomerate-sandstone-arkose and greywacke-argillite for sample 1.01, and 91.6% for sample 2.01.

The samples contained approximately 5% fair aggregate (a value of greater than 15% was reported by Laboratory 22 (1.01 only)) and less than 1% combined poor and deleterious aggregate (values of 2.4% or more were reported by Laboratories 15, 22, 172 (1.01 only), and 188 (2.01 only)). The fair aggregate consisted mainly of soft or slightly shaley carbonate, whose presence in amounts exceeding 1% was reported by all laboratories except 19, 72, 98 (2.01 only), 101, and 203. The poor aggregate consisted mainly of shaley carbonate, and the deleterious aggregate of shale.

A need for Laboratories 15, 22, 172, and 188 to modify their rock quality classification system is indicated. Laboratories 22 and 188 were selected as outliers using the iterative technique. The standard deviation in 2001 is considerably lower than in previous years. Some laboratories need to improve their ability to recognise different type of rocks.

The related ASTM standard for this test, C-295, does not report a petrographic number and has no precision statement.

2.3.9 Petrographic Analysis (Fine Aggregate)

The fine aggregate examined in 2001 was concrete sand from the Erie Sand and Gravel Leamington pit (MTO MAIDB Number E02-020).

Analysts from eight laboratories examined samples 1.01 and 2.01, and submitted work sheets showing subdivision according to rock/mineral type (silicate, carbonate, shale, mica, chert, contamination, and cementation) and sieve size. Laboratories 101 and 203 used the same analyst. The results are shown in the appendix and were evaluated by D.A. Williams, MTO Petrographer.

The samples contained an average of approximately 42% silicate, 21% carbonate, 33% shale, 1% mica, and 3% chert (silicate and mica contents increased from larger to smaller sieve sizes, and shale and chert contents decreased). Values of silicate content of greater than 55% were reported by Laboratory 37; carbonate content greater than 30% by Laboratories 37 and 188; shale content less than 20% by Laboratory 37; mica content greater than 2% by Laboratory 196; and chert content 1% or less by Laboratories 37 (1.01 only) and 295.

A need for Laboratories 37, 188, 196, and 295 to modify their rock/mineral type classification system is indicated. Only eight laboratories have reported results for this test, because of this no statistical analysis was performed.

The related ASTM standard for these tests, C-295, has no precision statement.

2.3.10 Micro-Deval Abrasion (Coarse Aggregate) - Test No. 16

Sixty-five laboratories reported results for this test in 2001. The test method requires reporting of control sample results to demonstrate that the testing process is in control. This year, two laboratories reported control sample results outside the established range and those two labs were excluded from the analysis. Three outliers were rejected using the iterative technique. The standard deviation (0.49) and coefficient of variation (7.3%) are comparable to the multi-laboratory standard deviation 0.5 and coefficient of variation of 10%, published in the test method (LS-618).

2.3.11 Freeze-Thaw Loss - Test No. 17

Fifty-two laboratories reported results for this test. The test method requires reporting of laboratory control sample losses to demonstrate that the testing process is in control. This information is used to alert the laboratory to testing deficiencies. Without testing of the reference material, the test is invalid (see LS-614, section 9.1). This year, three laboratories reported control sample data outside the established range, and those three

labs were excluded from the analysis. No outlier was selected using either three standard deviation or iterative technique. Variation is slightly higher than multi-laboratory precision statements published in LS-614. The scatter diagram shows evidence of a strong laboratory bias for this test. It is likely that there are two main reasons for the wide spread in data: insufficient damage caused by freezing which is due to freezing too rapidly or difference in sieving intensity. Laboratories should modify their processes to try and achieve losses closer to the mean loss of the control aggregate. LS-614, Revision 18 (Appendix 1) in the MTO Laboratory Testing Manual gives a procedure for determining and adjusting sieving time for quantitative analysis.

2.3.12 Sieve Analysis (Fine Aggregate) - Test Nos. 20-25

The samples for this procedure were prepared by the participants from the material passing 4.75 mm of the coarse aggregate gradation. This process more closely follows the normal testing procedure in which the laboratory prepares its own test samples from the field sample. The scatter diagrams for the fine aggregate sieve analysis show random variation, except for the 75 μm fraction, where some systematic bias due to operator/laboratory differences is apparent. As in previous inter-laboratory studies, it was found that the precision of the test varies as a function of the amount of material retained on any sieve. The smaller the amount of material retained on the sieve, the more efficient the sieving process, and the better the precision. When there is a small amount of material on a sieve (one layer of particles or less), the particles have a greater chance of falling through the sieve in a given time.

Outliers were selected using the iterative technique. Outlier labs with very low percent passing the 75 μm sieve should inspect their sieves, as low percent passing may be the result of the sieve being blinded when washing the sample. An ineffective washing process will also result in low percent passing.

2.3.13 Relative Density (Fine Aggregate) - Test No. 27 and Absorption (Fine Aggregate) - Test No. 28

Eighty-five laboratories performed these tests in 2001. The scatter diagrams for these tests show systematic variation. Seven outliers were selected using the three standard deviation technique. As in previous years, greater variation exists in this test compared to the relative density test on coarse aggregate. It is thought that the differing technique in arriving at the saturated surface dry condition (towelling for coarse aggregate vs. air-current drying and continuous stirring for fine aggregate) is responsible for this variation. It is imperative that differential drying of the various sized particles be avoided by *constant* stirring of the sample under the air current during the drying process. As short as 30 seconds periods of rest can be detrimental for the outcome of the test results. Differential drying of the particles is known to cause premature collapse in the cone test used to judge the saturated surface dry state. The resulting test observations are lower relative densities and higher absorption values. The multi-laboratory variation of the relative density test is less than the variation stated in ASTM C128.

This test shows gradual improvement in precision over the past four years, i.e., since 1997. This is probably due to generally improved equipment and operator performance as a result of the laboratory inspection process.

2.3.14 Magnesium Sulphate Soundness (Fine Aggregate) - Test No. 29

Thirty-five laboratories participated in this test in 2001. Two outliers were detected using the iterative technique. All the data are accounted in the lower left (quadrant 3) and upper right (quadrant 1) with the axis of scatter of points at approximately 45 degrees. As in previous years, the scatter diagram shows strong laboratory bias.

2.3.15 Amount of Asphalt Coated Particles in Coarse Aggregate - Test No. 30

The Amount of Asphalt Coated Particles in Coarse Aggregate Test was included in the Correlation Program in 2001. Two hundred and two laboratories reported results for this test. Twelve laboratories were selected as outliers using the iterative technique. The scatter plot shows combination of random variation and laboratory bias for some of the laboratories. There is no comparable or similar ASTM test procedure, and no precision statement has been established by MTO.

2.3.16 Moisture-Density Relationship (One-Point Method) Test Nos. 31- 33

One hundred and forty four laboratories reported results for this procedure. The outliers were rejected using the three standard deviation technique. The number of laboratories selected as outliers (10 to 17) is considerably higher than in previous years. The scatter plots show systematic variation for these tests. The possible causes for this variation may be misinterpretation of the test method and use of an improper mould even though, the participants were requested to use only the material passing 4.75 mm sieve and 152.4 mm diameter mould. In addition, this test requires significant operator skill to obtain the point within the band in the first attempt. Those laboratories with poor ratings should examine their equipment and procedure to discover the causes for this variation. Variations in this year are slightly less than in previous years. There are no ASTM precision statements for these tests.

2.3.17 Micro-Deval Abrasion (Fine Aggregate) - Test No. 34

Participants were asked to prepare their own test sample from the bulk sample provided. Sixty-four laboratories participated in this test in 2001. The test method requires reporting of control sample test results to demonstrate that the testing process is in control. All laboratories, with the exception of two, reported control samples within the acceptable range. The laboratories, which reported the results outside the established range were excluded from the analysis. The scatter diagram shows systematic bias. No outlier was selected using either the three standard deviation or iterative techniques. The standard deviation (0.9) as well as the coefficient of variation

(8%) is significantly lower than in previous years and slightly higher than the multi-laboratory coefficient of variation (6%) published in the test method (LS-619).

2.3.18 Particle Size Analysis of Soil - Test Nos. 40 - 45

Eighty-seven laboratories carried out the hydrometer test in 2001. Test 40 is reported for information purposes only, because 80 percent of laboratories reported 100% passing 2.00 mm. Outliers for Test No. 41 and 42 were selected using the three standard deviation technique, and for Test Nos. 43 to 45 were selected using the iterative technique.

Participants were requested to perform the test according to MTO LS-702, Revision No.19 and to verify this, they were asked to submit the data sheet. Based on the data sheet, fifteen laboratories did not perform the test in accordance with test procedure and these were excluded from the analysis.

The scatter diagrams show noticeable improvement compared to previous years, however, significant laboratory biases, especially in the case of percent passing 2μm and 5μm, still remain. The standard deviations for each of these particle sizes are significantly lower than in previous years.

The laboratories that are identified as outliers should examine their equipment and procedure very carefully to make certain all is within specification and the procedure is followed exactly.

2.3.19 Atterberg Limits of Soil - Test Nos. 46-48

Eighty-one laboratories reported Atterberg Limits for soil in 2001. Seven outliers were identified using the iterative technique. The scatter plots for both Liquid and Plastic Limits show systematic variation. This variation is characteristic of tests that require significant operator skills, and good condition and calibration of the apparatus. In previous years, with the exception of 1999, the standard deviation for the liquid limit test has always been higher than for the plastic limit, and the same trend is reflected in this year's results. Close attention to the condition and calibration of the liquid limit apparatus and employing skilled technicians may reduce these biases.

This year, variations for all three tests, i.e., liquid, plastic limits, and plasticity index are significantly lower than in previous years. ASTM has recently revised the precision statements for this test, based on results from twenty-four laboratories. The standard deviations are comparable to the values that are now published in ASTM, and in the case of plastic limit, it is less than that of ASTM.

2.3.20 Specific Gravity of Soils - Test No. 49

Sixty-three laboratories reported results for this test. The participants were requested to perform the test on minimum of three specimens in accordance with the procedures described in Section 9.1of ASTM D 854. They were asked to submit the data sheet to verify weather the range, i.e., the difference between the largest and smallest value, is

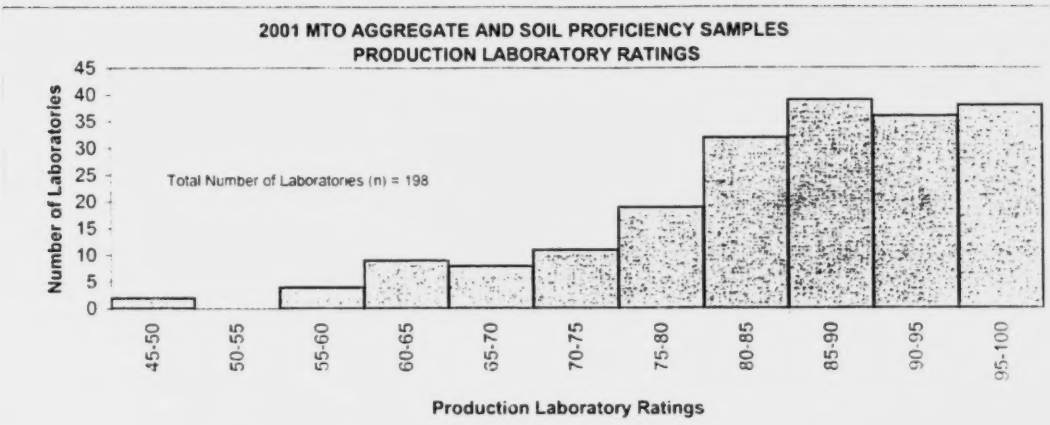
within the limit specified in the test method. Based on the data sheet, seven laboratories were excluded from the analysis for exceeding the limit. One outlier was detected using the three standard deviation technique. The scatter plot shows improvements compared to previous years, however, some laboratory bias still remains. Several steps in this test procedure can influence the results. Particularly, the equipment and method employed for preparation of test specimen as well as for removal of air entrapped in the pycnometer or flask. The possible cause for the bias may be because the laboratories do not fully comply with the test procedures. Laboratories finding themselves in this situation should examine their equipment and procedure very carefully.

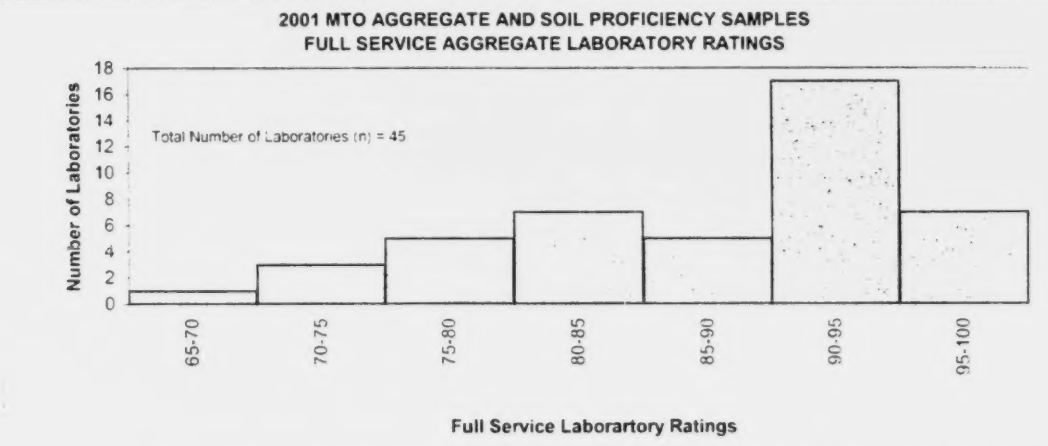
The standard deviation in 2001 is considerably less than in previous years and the multi-laboratory variation limit specified in ASTM precision statement.

3.0 LABORATORY RATING SYSTEM

The laboratory rating system, applied to all participating laboratories, was devised in 1997. The rating system assigns separate laboratory ratings for low complexity (production) aggregate laboratories, high complexity (full service) aggregate laboratories, and for soil laboratories. Low complexity laboratories are required to carry out wash pass 75 µm, gradation, percent crushed particles, percent asphalt coated particles, and optional, percent flat and elongated particles. In addition to those low complexity tests, high complexity laboratories must carry out micro-Deval (coarse and fine), freeze-thaw and/or magnesium sulphate soundness, relative density and absorption (coarse & fine). Forty-five (45) high complexity (full service) aggregate laboratories participated in the program in 2001. Soil laboratories are required to carry out particle size analysis, Atterberg limits and specific gravity of soil. Fifty-four laboratories that test soils have participated in all three tests in 2001.

The rating system gives a maximum of 10 for each test, *e.g.* 5 for wash pass 75 µm on sample 1.01, plus -5 for wash pass 75 µm on sample 2.01, equals 10 (the negative sign indicating a test result less than the mean is ignored). Some tests that are normally reported together are averaged and given a maximum of 10. The relative density and absorption (coarse and fine), one-point Proctor values (maximum wet and dry density, and optimum moisture content) and particle size analysis of soils are treated in this manner. Because of the large number of individual test ratings in the gradation results, the ratings (out of 10) for each sieve, coarse and fine, are multiplied by three so as not to unduly bias the overall balance between various tests. The ratings for each sieve size are added and then divided by the number of sieves for which results were reported, and multiplied by 3 to give a laboratory rating with a maximum of 30 for this test. Aggregate and soil laboratory ratings are given in Figure 3 in the form of charts. The laboratory rating system data is reported in the appendix.





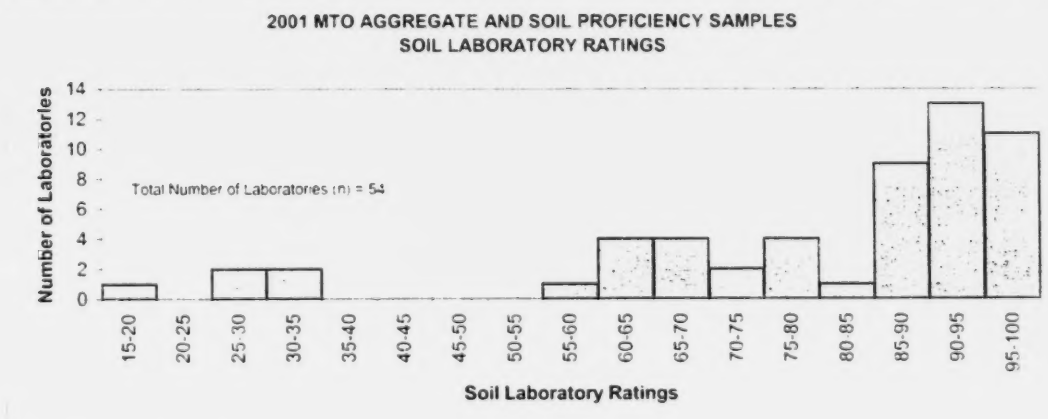


Figure 3 Laboratory Ratings

Laboratory ratings are given in the covering letter accompanying this report to individual laboratories. A poor or good rating for a laboratory in one year is an indication of how that laboratory performed in the proficiency study, and may not be a reflection of how the laboratory performs year round. A consistently poor rating over two or more years may be cause for serious concern.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Since 1999, the samples have been prepared with a large spinning riffler. This method of sample preparation resulted in no significant (coarse aggregate) mean gradation differences between samples 1.01 and 2.01. In fact, variations for sieve analysis results in 2000 and 2001 are less than in the previous years and significantly lower than the variations given in the ASTM precision statements. The differences in mean as well as in variations between pairs of samples for both, coarse and fine sieves, are none to negligible. Based on the results, it may be concluded that the sample preparation method employed is very effective and capable of producing a uniform material at reasonable cost.

In addition to the sieve analysis results, other test results of the 2000 Proficiency Sample Program not only compare favourably but also in many cases show noticeable improvement over previous year's results. These tests include the wash pass 75 μm, Los Angeles abrasion, relative density and absorption (coarse and fine), percent crushed particles, Petrographic number (concrete) one-point proctor and Micro-Deval (fine). These aggregate tests are probably showing improvement, in large part, due to the CCIL laboratory inspection and certification program, which began in 1998, and due to increased awareness of the importance of proper testing. Aggregate quality has a larger effect on the variation exhibited in some tests, and a smaller effect in others. For example, the Micro-Deval Abrasion test exhibits reduced variation as lower total loss is reported. On the other hand, a sieve analysis could be performed on those same two aggregates, with the percentage passing and the variation being remarkably similar for the two samples.

The number of laboratories participated in soil tests in 2001 have increased substantially. In the case of hydrometer analysis, the number of participants has increased from sixty-three to eighty-seven, whereas in specific gravity test, it has increased from forty-three to sixty-three. The results of all three soils tests, i.e., particle size analysis, Atterberg Limits and specific gravity of soil, show marked improvements over previous years. The variations in Atterberg limit results are significantly lower than in previous years and comparable to values published in the ASTM. Specific gravity results show significantly lower variation than in previous years and in the ASTM precision statement. The soil tests are probably showing noticeable improvement, in part, due to the soil laboratory inspection program, which MTO implemented in 1999, and due to increased awareness of the importance of proper testing. It is expected that the soil laboratory inspection process that is being carried out by MTO[9] will bring about improvements in variation.

Although, there are noticeable improvements in the results, the number of laboratories identified as outliers in most of the test is considerably higher than previous years. These laboratories should examine the condition and calibration of equipments, testing procedures, and skills of the technicians.

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[9] To arrange an inspection of your Soil Laboratory, please contact Mark Vasavithasan, Aggregate Testing Standards Engineer, Soils and Aggregates Section, Ministry of Transportation, phone (416) 235 – 4901, fax (416) 235 – 4101.

The results of the 2000 MTO Aggregate and Soil Proficiency Sample Program suggest that most laboratories have satisfactory within-laboratory precision, meaning that they can test two similar samples and get similar results. Multi-laboratory precision, meaning the ability of different laboratories to test similar samples and get similar results, needs to be improved for a number of the tests. If good multi-laboratory precision is to be obtained, operator training, standardization and calibration of equipment, and laboratory environment should be a main focus. For many test procedures the equipment to be used is regulated by the method but a good state of repair and the correct calibration are sometimes lacking. It is hoped that the CCIL Type D inspection process implemented in the fall of 1999 will go a long way to ensure that the laboratories have the correct equipment and trained technicians to perform the tests. Laboratories will find that a well-documented and regular program of internal inspection, calibration, and testing of control or reference samples, are beneficial to maintaining a high level of confidence in their results.

Appendix

Glossary of Terms

Precision refers to the degree of mutual agreement between individual measurements on the same material. In other words, precision is a measure of how well the individual test results of a series agree with each other.

Accuracy refers to the degree of mutual agreement between a set of measurements with an accepted reference or 'true value.' This 'true' or reference value can be an assigned value arrived at by actual experiments.

Bias of a measurement process is a consistent and systematic difference between a set of test results derived from using the process, and an accepted reference value of the property being measured. For the majority of aggregate and soil tests there is no acceptable reference material, so bias is impossible to compute.

Coefficient of Variation expresses the standard deviation as a percentage of the mean, where:

$$C.V. = \frac{\text{std dev}}{\text{mean}} \times 100$$

Single operator precision (one-sigma limit (1s)) indicates the variability, as measured by the deviations above and below the average, of a large group of individual test results when the tests have been made on the same material by a single operator using the same apparatus in the same laboratory over a relatively short time.

Multi-laboratory precision (one-sigma limit (1s)) is a quantitative estimate of the variability of a large group of individual test results when each test has been made in a different laboratory and every effort has been made to make test portions of the material as nearly identical as possible. Under normal circumstances the estimates of the one-sigma limit for multi-laboratory precision are usually larger than those for single operator precision because different operators and different equipment are being used in different laboratories.

Acceptable difference between two results (difference two-sigma limit (d2s)) as an index of precision is the maximum acceptable difference between two results obtained on test portions of the same material tested by two different laboratories. The index, d2s, is the difference between two individual test results that would be equalled or exceeded in only one case in twenty in the normal and correct operation of the method. The index is calculated by multiplying the multi-laboratory standard deviation (1s), by the factor $2\sqrt{2}$ (2.83).

Sample mean or average is the sum of all observations divided by the total number of observations.

Median is synonymous with the middle and the **sample median** is the middle value of a list of test results when the observations are ordered from smallest to largest in magnitude. After rearranging the observations in increasing order (from most negative to most positive), the **sample median** is the *single middle value* in the ordered list, if n is odd, or the *average of the two middle values* in the ordered list, if n is even, where n equals the number of observations.

Standard deviation is the most usual measure of the dispersion of observed values or results expressed as the positive square root of the variance.

Variance is a measure of the squared dispersion of observed values or measurements expressed as a function of the sum of the squared deviations from the population mean or sample average.

Outlier is a measurement that, for a specific degree of confidence, is not part of the population. In this study, an outlier is generally three or more standard deviations from the mean, giving a confidence level of ninety-nine percent. If a laboratory test result is classified as an outlier it means something went wrong either with the sample or in the laboratory.

2001 Participants List

Ministry of Transportation
Aggregate and Soil
Proficiency Sample
Testing Program

For further information on this program
Contact Mark Vasavithasan (416) 235-4901
or Chris Rogers (416) 235-3734

	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils	LS- 623 One Point Proctor Density
3M Canada Co. Havelock, ON Mr. F. Stanisic Tel: 05 778-3341	✓	✓				✓	✓							✓				
A. L. Blair Construction Limited Moose Creek, ON Mr. B. Blanshard Tel: 613 538-2271	✓	✓				✓								✓				
Acculab Engineering and Testing Schumacher, ON Mr. H.R. Jones Tel: 705 360-5252	✓	✓				✓	✓							✓				✓
Acres International Limited Niagara Falls, ON Mr. R. Serluca Tel: 905 374-5200	✓	✓											✓	✓	✓	✓	✓	
AGS Associates Inc. Scarborough, ON Mr. A. Chohan Tel: 416 299-3655	✓	✓		✓	✓	✓	✓				✓	✓		✓	✓	✓	✓	✓
AMEC Earth & Environmental Ltd Scarborough, ON Mr. S. Sufi Tel: 416 751-6565	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
AMEC Earth & Environmental Ltd Windsor, ON Mr. C. Ellsworth Tel: 519 969-7530	✓	✓				✓								✓				
AMEC Earth & Environmental Ltd. Hamilton, ON Mr. J. Balinski Tel: 905 312-0700	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
AMEC Earth & Environmental Ltd. London, ON Mr. S. Burt Tel: 519 681-2400	✓	✓				✓	✓							✓	✓	✓		✓
AMEC Earth & Environmental Ltd. Orillia, ON Mr. L. Knegt Tel: 705 329-1542	✓	✓				✓	✓							✓	✓			✓
AMEC Earth & Environmental Ltd. Thorold, ON Mr. A. Markov Tel: 905 687-6616	✓	✓		✓		✓	✓	✓						✓	✓	✓	✓	✓
AMEC Earth & Environmental Ltd. Waterloo, ON Mr. L. Maier Tel: 519 885-6220	✓	✓				✓								✓	✓	✓	✓	✓
Armbro Materials Engineering Brampton, ON Mr. T. Dziedziejko Tel: 905 840-5914	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓
Armbro Materials Engineering – East Gormley, ON Mr. B. Dobson Tel: 905 887-1469	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Armbro Materials Engineering Mobile 1 (24-270) Brampton, ON Mr. T. Dziedziejko Tel: 905 840-5914	✓	✓				✓								✓				✓
Armbro Materials Engineering Mobile 2 (24-165) Brampton, ON Mr. T. Dziedziejko Tel: 905 840-5914	✓	✓				✓								✓				✓
Armbro Materials Engineering Mobile 3 (24-272) Brampton, ON Mr. T. Dziedziejko Tel: 905 840-5914	✓	✓				✓								✓				✓
Armbro Materials Engineering Mobile 4 (24-172) Brampton, ON Mr. T. Dziedziejko Tel: 905 840-5914	✓	✓				✓								✓				✓
Armbro Materials Engineering Mobile 5 (24-298) Brampton, ON Mr. T. Dziedziejko Tel: 905 840-5914	✓	✓				✓								✓				✓
Armbro Materials Engineering Mobile 6 (24-271) Brampton, ON Mr. T. Dziedziejko Tel: 905 840-5914	✓	✓				✓								✓				✓
Armbro Materials Engineering Mobile 7 (24-297) Brampton, ON Mr. T. Dziedziejko Tel: 905 840-5914	✓	✓				✓	✓				✓	✓		✓				
Ashwarren Engineering Services Ltd Mississauga, ON Mr. K. Wells Tel: 905 819-1290	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓		✓		✓

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Atkinson, Davies Inc. London, ON Mr. A. Connell Tel: 519 685-6400		✓				✓									✓	✓		
Beaver Road Builders Ltd Gloucester, ON Mr. B. Hendriks Tel: 613 822-6884	✓	✓		✓		✓	✓			✓	✓	✓		✓		✓	✓	✓
Bertrand Construction L'Original, ON Mr. G. Downing Tel: 613 675-4614	✓	✓				✓	✓							✓				
Block & Associates Winnipeg, MB Mr. T. Gluck Tel: 204 334-5356	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓
Brock Aggregates Inc. Concord, ON Mr. D. Santoro Tel: 800 870-8926	✓	✓																
Bruno's Contracting (Thunder Bay) Ltd. (#358) Thunder Bay, ON Mr. B. Prevost Tel: 807 623-1855	✓	✓				✓								✓				
Bruno's Contracting (Thunder Bay) Ltd. (#376) Thunder Bay, ON Mr. B. Prevost Tel: 807 623-1855	✓	✓				✓								✓				
C. Villeneuve Construction Hearst, ON Mr. C. Harris Tel: 705 372-1838	✓	✓				✓								✓				
C.T. Soil & Materials Engineering Inc. Windsor, ON Mr. R. Primeau Tel: 519 966-8863	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓		✓	✓	✓		✓
Caledon Sand & Gravel Ltd. Caledon, ON Mr. A. Warren Tel: 905 457-4537	✓	✓				✓	✓				✓	✓		✓				
Capital Paving Inc. (Aggregate Lab) Guelph, ON Mr. M. Latyn Tel: 519 822-4511	✓	✓				✓	✓							✓				✓
Capital Paving Inc. (Asphalt Lab) Guelph, ON Mr. M. Latyn Tel: 519 822-4511	✓	✓				✓	✓							✓				
Cayuga Materials & Construction Co. Ltd Cayuga, ON Mr. G. Taylor Tel: 905 772-3331	✓	✓		✓		✓	✓				✓	✓		✓				✓
CBM Aggregates Aberfoyle Lab Cambridge, ON Mr. L. Mugford Tel: 519 824-5384	✓	✓				✓	✓							✓				
CBM Aggregates London Lab London, ON Mr. L. Mugford Tel: 519 285-2583	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓				
CBM Leaside Lab Toronto, ON Mr. B. Schulz Tel: 416 423-2439	✓	✓		✓	✓	✓	✓			✓	✓	✓	✓	✓		✓		
CBM Sunderland Lab Sunderland, ON Mr. L. Mugford Tel: 416 862-1382	✓	✓				✓	✓							✓				
Chung & Vander Dollen Engineering Limited Kitchener, ON Mr. E. Chung Tel: 519 742-8979	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
City of Sault Ste Marie Sault Ste Marie, ON Mr. J. Sloan Tel: 705 946-9918	✓	✓				✓								✓				
Concrete Materials Lab, Dept of Engineering U. of Toronto Dr. R. D. Hooton Tel: 416 978-5912													✓					
Consoil Quality Control St. Catherines, ON Mr. J. Clunas Tel: 905 641-1162	✓	✓				✓	✓							✓	✓	✓		✓
Construction Control Inc. Woodbridge, ON Mr. A. Davis Tel: 905 856-1438	✓	✓		✓		✓	✓							✓	✓	✓		✓

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Construction Testing Asphalt Lab Oakville, ON Mr. P. Lung Tel: 905 469-6352	✓	✓		✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Cornwall Gravel Co. Cornwall, ON Mr. B. Mroz Tel: 613 932-6571	✓	✓				✓								✓				
Cox Construction Limited Guelph, ON Mr. D. Cox Tel: 519 824-6570	✓	✓				✓	✓							✓				
Cruickshank Construction Ltd Kingston, ON Mr. B. Green Tel: 613 542-2874	✓	✓				✓								✓				
Cruickshank Construction Ltd Morrisburg, ON Mr. J. Smith Tel: 613 543-2978		✓				✓								✓				✓
D.F. Elliott Consulting Engineering New Liskeard, ON Mr. B. Gilbert Tel: 705 647-6871	✓	✓				✓	✓							✓				✓
Davroc Testing Laboratories Inc. Brampton, ON Mr. S. Fasullo Tel: 905 792-7792	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DBA Engineering Limited Markham, ON Mr. C. Elvidge Tel: 905 940-8383	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			✓
DBA Engineering Limited Mobile 10 Markham, ON Mr. C. Elvidge Tel: 905 940-8383	✓	✓				✓	✓							✓				✓
DBA Engineering Limited Mobile 3 Markham, ON Mr. C. Elvidge Tel: 905 940-8383	✓	✓				✓								✓				✓
DBA Engineering Limited Mobile 5 Markham, ON Mr. C. Elvidge Tel: 905 940-8383	✓	✓				✓	✓							✓				✓
DBA Engineering Limited Mobile 6 Markham, ON Mr. C. Elvidge Tel: 905 940-8383	✓	✓				✓	✓							✓				✓
DBA Engineering Limited Mobile 7 Markham, ON Mr. C. Elvidge Tel: 905 940-8383	✓	✓				✓	✓							✓				✓
DBA Engineering Ltd. Kingston, ON Mr. W. McLatchie Tel: 613 389-1781	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓		✓
Dibblee Construction Limited Kingston, ON Mr. C. Smith Tel: 613 389-3232	✓	✓				✓	✓							✓				
Dibblee Paving & Materials (Boyce Lab) Gloucester, ON Mr. G. Gooderham Tel: 613 829-1770	✓	✓		✓		✓	✓							✓				
Dibblee Paving & Materials (Moodie Lab) Nepean, ON Mr. G. Goodeham Tel: 613 829-1770	✓	✓		✓		✓	✓				✓	✓		✓				✓
District Municipality of Muskoka Bracebridge, ON Mr. D. Wood Tel: 705 645-6764	✓	✓				✓								✓	✓	✓		✓
Drain Bros Excavating Ltd. Lakefield, ON Mr. D. Drain Tel: 705 639-2301	✓	✓				✓	✓				✓	✓		✓				✓
DST Consulting Engineers Inc. Kenora, ON Mr. J. Peterson Tel: 807 548-2383	✓	✓				✓	✓	✓						✓	✓	✓		✓
DST Consulting Engineers Inc. Mississauga, ON Mr. Loranger Tel: 905 501-7511	✓	✓				✓	✓							✓	✓	✓		✓
DST Consulting Engineers Inc. Thunder Bay, ON Mr. B. Cenedese Tel: 807 623-2929	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓

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DST Consulting Engineers Inc. Ottawa, ON Mr. C. Mahoney Tel: 613 748-1415	✓	✓				✓								✓	✓	✓		✓
Dufferin Aggregates Aberfoyle Lab – Loc. 3030 Guelph, ON Ms. T. Malpage Tel: 519 763-3499	✓	✓				✓	✓							✓				
Dufferin Aggregates Acton Quarry Acton, ON Mr. J. Stewart Tel: 519 853-2230	✓	✓				✓	✓							✓				
Dufferin Aggregates Brechin Lab – Loc. 3001 Milton, ON Ms. T. Malpage Tel: 705 484-0073	✓	✓				✓	✓							✓				
Dufferin Aggregates Millcreek Lab – Loc. 3031 Puslinch, ON Ms. T. Malpage Tel: 519 763-6991	✓	✓				✓	✓							✓				
Dufferin Aggregates Mosport Lab – Loc. 3032 Orono, ON Ms. T. Malpage Tel: 905 983-9289	✓	✓				✓	✓							✓				
Dufferin Aggregates Quality Control Lab – Loc. 3000 Milton, ON Mr. D. Stratton Tel: 416 798-4772	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓				
Dufferin Brantford Lab Acton, ON Mr. J. Stewart Tel: 519 853-2230	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓		
Dufferin Construction Ltd. (QC) – Bronte Lab Oakville, ON Mr. J. Tiwari Tel: 905 827-5750	✓	✓		✓		✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
Dufferin Construction Ltd. Mobile Lab No. 1 Oakville, ON Mr. J. Tiwari Tel: 905 827-5750	✓	✓		✓		✓	✓							✓				✓
Dufferin Construction Ltd. Mobile Lab No. 2 Oakville, ON Mr. J. Tiwari Tel: 905 827-5750	✓	✓		✓		✓	✓				✓	✓		✓	✓	✓	✓	✓
E.C. King Contracting Lab #1 Owen Sound, ON Mr. H. Villneff Tel: 519 376-6140	✓	✓		✓		✓	✓							✓				
Forwell Limited Kitchener, ON Mr. B. Sugg Tel: 519 740-0612	✓	✓				✓	✓							✓				
Fowler Construction Company Bracebridge, ON Mr. M. Rand Tel: 705 645-2214	✓	✓		✓		✓	✓							✓				✓
Fowler Construction Company Mobile1 Bracebridge, ON Mr. T.G. Fawcett Tel: 705 645-2214	✓	✓				✓								✓				✓
Franceschini Bros. Aggregates Ltd. Mississauga, ON Mr. H. Bykerk Tel: 905 277-1471	✓	✓				✓								✓				
G. Tackaberry & Sons Construction Co. Ltd. Athens, ON Mr. P. Rodgers Tel: 613 924-2634	✓	✓				✓	✓							✓				✓
Gamble Construction Ltd. (87526) Dryden, ON Mr. H. Villneff Tel: 807 223-2844	✓	✓				✓	✓							✓				✓
Gamble Construction Ltd. Mobile 2 Dryden, ON Mr. H. Villneff Tel: 807 223-2844	✓	✓				✓	✓							✓				✓
Gamsby and Mannerow Limited Owen Sound, ON Mr. B. Dubeau Tel: 519 376-1805	✓	✓				✓								✓				✓
Gazzola Paving Ltd. Etobicoke, ON Mr. S. Andualem Tel: 416 675-7007	✓	✓		✓		✓	✓							✓				
Geo-Logic Inc. Peterborough, ON Mr. W. Rayfuse Tel: 705 749-3317	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓

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Geo-Logic Inc. Pembroke, ON Ms. E. Reid Tel: 613 735-8361	✓	✓				✓								✓				✓
Georgian Aggregates & Construction Inc. Lab No. 1 Collingwood, ON Mr. B. Stone Tel: 705 445-2300	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓				
Georgian Aggregates & Construction Inc. Lab No. 2 Collingwood, ON Mr. B. Stone Tel: 705 445-2300	✓	✓		✓	✓	✓	✓			✓	✓			✓				
Golder Associates Ltd. London, ON Mr. W.M. Kellestine Tel: 519 471-9600	✓	✓		✓		✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
Golder Associates Ltd. Mississauga, ON Ms. M. Manojlovic Tel: 905 567-4444	✓	✓		✓		✓								✓	✓	✓	✓	✓
Golder Associates Ltd. Ottawa, ON Mr. C. Smith Tel: 613 224-5864	✓	✓													✓	✓	✓	✓
Golder Associates Ltd. Sudbury, ON Ms. K. Salvatori Tel: 705 524-6861	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Golder Associates Ltd. Whitby, ON Mr. J. Kimmett Tel: 905 723-2727	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Golder Associates Ltd. Windsor, ON Mr. J.D. Rodger Tel: 519 945-5500	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Graham Brothers Brampton, ON Mr. G. Thompson Tel: 905 453-1200	✓	✓		✓		✓	✓				✓	✓		✓		✓		✓
Grant Paving & Materials (1254) New Liskeard, ON Mr. H. Villneff Tel: 705 647-4331	✓	✓				✓	✓				✓	✓		✓				✓
Grant Paving & Materials (60-889) New Liskeard, ON Mr. H. Villneff Tel: 705 647-4331	✓	✓				✓	✓							✓				✓
Grant Paving & Materials Mobile #60900 New Liskeard, ON Mr. H. Villneff Tel: 705 647-4331	✓	✓				✓	✓							✓				✓
Hard Rock Paving Port Colborne, ON Ms. J. Koros Tel: 905 834-4581	✓	✓				✓	✓				✓	✓		✓				✓
Harold Sutherland Construction Ltd. Kemble, ON Mr. R. Leigh Tel: 519 376-0603	✓	✓		✓		✓	✓							✓				
Holger Lohse, Consulting Geologist Mississauga, ON Mr. H. Lohse Tel: 905 812-1539								✓	✓									
Huron Construction Lab No. 1 Chatham, ON Mr. D. Smith Tel: 519 354-0170	✓	✓				✓								✓				✓
Inspec-sol Inc. Kingston, ON Mr. S. Grainger Tel: 613 389-9812	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Inspec-Sol Inc. Mississauga, ON Mr. K. Roechner Tel: 905 712-4771	✓	✓				✓								✓	✓	✓		✓
Intratech Engineering Laboratories Inc. Scarborough, ON Mr. S. Dattani Tel: 416 754-2077	✓	✓		✓	✓	✓	✓			✓				✓				✓
J & P Leveque Bros. Ltd. Bancroft, ON Mr. W. Linnen Tel: 613 332-5533	✓	✓				✓	✓				✓	✓		✓		✓		✓
J & P Leveque Bros. Ltd. Mobile 1 Bancroft, ON Mr. W. Linnen Tel: 613 332-5533	✓	✓				✓	✓				✓	✓		✓		✓		✓

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J. T. Donald Consultants Limited Toronto, ON Mr. R. W. Robins Tel: 416 751-5230	✓	✓				✓								✓				✓
Jacques Whitford Limited Ottawa, ON Mr. G. Lavallee Tel: 613 738-0708	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Jacques Whitford Limited Markham, ON Mr. I. Patel Tel: 416 495-8614	✓	✓				✓								✓	✓	✓		✓
Jacques Whitford Limited Mobile Lab Ottawa, ON Mr. G. Lavalle Tel: 613 738-0708	✓	✓				✓								✓				✓
John D. Paterson & Associates Nepean, ON Ms. S. Walker Tel: 613 226-7381	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓		✓	✓	✓	✓	✓
John D. Patterson & Associates North Bay, ON Mr. C. Pelletier Tel: 707 472-5331	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓				✓
John Emery Geotechnical Engineering Limited Etobicoke, ON Mr. M. MacKay Tel: 416 213-1060	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
John Emery Geotechnical Engineering Limited Hamilton, ON Mr. W. Lupton Tel: 905 574-3552	✓	✓				✓	✓							✓				✓
John Emery Geotechnical Engineering Mobile 4 Chatham, ON Mr. D. Soanes Tel: 416 213-1060	✓	✓				✓								✓				✓
John Emery Geotechnical Engineering Mobile 6 Toronto, ON Mr. D. Soanes Tel: 416 213-1060	✓	✓				✓								✓				✓
K.J. Beamish Construction King City, ON Mr. F. Magisano Tel: 905 833-4666	✓	✓		✓		✓	✓	✓			✓	✓		✓		✓		✓
K.J. Beamish Construction Mobile 1 King City, ON Mr. F. Magisano Tel: 905 833-4666	✓	✓				✓	✓							✓				✓
Karson Kartage & Konstruction Stittsville, ON Mr. C. MacDonald Tel: 613 831-0717	✓	✓		✓	✓	✓	✓			✓	✓	✓	✓	✓				
Lafarge Canada Brechin Plant Brechin, ON Ms. C. Hutchinson Tel: 705 484-5225	✓	✓		✓		✓	✓							✓				
Lafarge Canada Coldwater Plant Brechin, ON Ms. C. Hutchinson Tel: 705 484-5225	✓	✓				✓	✓							✓				
Lafarge Canada Inc. Stouffville, ON Mr. M. Hicks Tel: 905 640-7092	✓	✓		✓		✓	✓							✓				
Lafarge Canada Inc. – Fonthill Lab Acton, ON Mr. N. Misdorf Tel: 519 853-2230	✓	✓				✓	✓							✓				
Lafarge Canada Inc. – Hamilton Lab Hamilton, ON Mr.R. Parizeau Tel: 905 522-7735 x247	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓				
Lafarge Construction - Barrie Barrie, ON Mr. K. Cathcart Tel: 705 726-6424	✓	✓				✓	✓							✓				
Lafarge Construction Barrie Lab #2 Barrie, ON Mr. K. Cathcart Tel: 705 726-6424	✓	✓				✓	✓							✓				
Lafarge Construction Materials Ltd. Brockville, ON Mr. P. Arkeveld Tel: 613 342-0262	✓	✓				✓	✓			✓	✓	✓		✓				
Lafarge Hamilton Slag Limited Hamilton, ON Mr. J. Westoby Tel: 905 547-2133	✓	✓				✓								✓				

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Lafarge Quarries (Dundas Lab) Dundas, ON Mr. M. Koch Tel: 905 527-3671	✓	✓		✓		✓	✓			✓	✓	✓		✓				
Lafarge Canada Inc. Montreal, QUE. Ms. M. de Grosbois Tel:													✓					
Landtek Limited Hamilton, ON Mr. P. Anderson Tel: 905 383-3733	✓	✓		✓		✓	✓				✓	✓		✓	✓	✓	✓	✓
Lavis Contracting Co. Limited Clinton, ON Mr. A. Gardner Tel: 519 482-3694	✓	✓				✓								✓				
Law Engineering (London) Inc. London, ON Mr. J. Law Tel: 519 680-9991	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
Leo Alarie & Son Ltd. Timmins, ON Mr. J. Luthe Tel: 705 268-2106	✓	✓				✓	✓							✓				
M.J. Labelle Co. Ltd. Mobile 1 Cochrane, ON Mr. G. Paquette Tel: 705 272-4201	✓	✓				✓								✓				✓
M.J. Labelle Co. Ltd. Mobile 2 Cochrane, ON Mr. G. Paquette Tel: 705 272-4201	✓	✓				✓								✓				✓
M.R. Wright & Associates Sault Ste. Marie, ON Mr. R. Wilson Tel: 705 945-5091	✓	✓		✓	✓	✓	✓				✓	✓		✓	✓	✓	✓	✓
Mark Smereczynsky Petrographic Services Etobicoke, ON Mr.M. Smereczynsky Tel: 416 626-3505								✓	✓									
Merlex Engineering Ltd. North Bay, ON Mr. M. Merleau Tel: 705 476-2550	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Mill-Am Corporation Lab #890901 Windsor, ON Mr. A. Saifan Tel: 519 945-7441	✓	✓				✓	✓							✓				✓
Miller Paving Ltd. (1084) Timmins, ON Mr. H. Villaneff Tel: 705 267-1107	✓	✓				✓	✓							✓				✓
Miller Paving Ltd. (Markham Lab) Markham, ON Mr. J. Lougman Tel: 905 475-6660	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓		✓		✓
Miller Paving Ltd. Carden Quarry Lab Markham, ON Mr. J. Lougman Tel: 705 484-0195	✓	✓				✓	✓							✓				
Miller Paving Ltd. North Bay (#8661) North Bay, ON Mr. H. Villneff Tel: 705 472-3312	✓	✓				✓	✓							✓				✓
Miller Paving Ltd. Whitby Lab Markham, ON Mr. J. Lougman Tel: 705 484-0195	✓	✓		✓		✓	✓							✓				✓
Ministry of Transportation Downsview, ON Mr. C. Rogers Tel: 416 235-3734	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mulder Construction & Materials Limited –Unit # 7004 West St. Paul, MB Mr. D. Walker Tel: 204 958-7400	✓	✓				✓								✓				
Mulder Construction & Materials Limited –Unit # 7005 West St. Paul, MB Mr. D. Walker Tel: 204 958-7400	✓	✓				✓								✓				
National Testing Laboratories Ltd. Winnipeg, MB Mr. D. Flatt Tel: 204 488-6999	✓	✓	✓	✓		✓	✓							✓	✓	✓	✓	✓
Naylor Engineering Associates Ltd Kitchener, ON Ms. A. Snyder Tel: 519 741-1313	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓

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Nelson Aggregate Co. Brantford, ON Mr. T. Sayer Tel: 519 756-0530	✓	✓				✓	✓							✓				
Nelson Aggregate Co. Beamsville, ON Mr. T. Scambato Tel: 905 563-8226	✓	✓				✓	✓							✓				
Nelson Aggregate Co. Burlington, ON Mr. M. Rook Tel: 905 336-0453	✓	✓				✓	✓							✓				
Oliver Mangione McCalla & Associates (Trow) Nepean, ON Mr. I.M. Taki Tel: 613 225-9940	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Peto MacCallum Ltd. Barrie, ON Mr. A. Jones Tel: 705 734-3900	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Peto MacCallum Ltd. Brampton, ON Mr. R. Midgley Tel: 905 796-3650	✓	✓		✓		✓	✓							✓				✓
Peto MacCallum Ltd. Hamilton, ON Mr. E.L. Truax Tel: 905 561-2231	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Peto MacCallum Ltd. Kitchener, ON Mr. E. Clarkson Tel: 519 893-7500	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Peto MacCallum Ltd. Toronto, ON Mr. A. Nathoo Tel: 416 785-5110	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Peto MacCallum Ltd. Mobile 3 Toronto, ON Mr. P. Sun Tel: 416 785-5110		✓		✓			✓							✓				✓
Pioneer Construction Inc. (Main Lab) Sudbury, ON Mr. K. Edwards Tel: 705 560-7200	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓		✓	✓	✓
Pioneer Construction Inc. (Mobile 1) Sudbury, ON Mr. K. Edwards Tel: 705 560-7200	✓	✓				✓	✓							✓				✓
Pioneer Construction Inc. (Mobile 2) Sudbury, ON Mr. K. Edwards Tel: 705 560-7200	✓	✓				✓	✓							✓				✓
Precision Age Aggregate Testing Ltd Thunder Bay Mr. W. Werbowetski Tel: 807 577-3927								✓	✓									
Regional Municipality of Durham, Materials Testing Whitby, ON Mr. R. Trewin Tel: 905 668-7721	✓	✓		✓		✓								✓				✓
Royel Paving Limited Mobile 1 Lindsay, ON Mr. M. Minaker Tel: 705 324-6773	✓	✓				✓	✓							✓				✓
Sarafinchin Associates Ltd. Rexdale, ON Mr. S. Jeffrey Tel: 416 674-1770	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Shaheen & Peaker Limited Etobicoke, ON Mr. A. Mendonca Tel: 416 213-1255	✓	✓				✓	✓							✓	✓	✓	✓	✓
Shaheen & Peaker Limited (Geo-Canada) Markham, ON Mr. S. Peaker Tel: 905 474-9255	✓	✓												✓	✓	✓	✓	✓
Shaheen Peaker Thompson Limited Oshawa ON Mr. D. Thompson Tel: 905 436-9028	✓	✓		✓	✓	✓	✓			✓				✓	✓	✓	✓	✓
Smelter Bay Aggregates Inc. Thessalon, ON Mr. R. Gardiner Tel: 705 842-3908	✓	✓				✓	✓							✓				
Smith's Construction Arnprior Ltd Mobile 1 (s660) Arnprior, ON Mr. H. Villneff Tel: 613 623-3144	✓	✓				✓	✓							✓				✓

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Smith's Construction Arnprior Ltd Mobile 2 (60-853) Arnprior, ON Mr. H. Villneff Tel: 613 623-3144	✓	✓				✓	✓							✓				✓
Soil Probe Limited Scarborough, ON Mr. A. Memon Tel: 416 754-7055	✓	✓		✓		✓								✓	✓	✓	✓	✓
Soil-Eng Limited Scarborough, ON Mr. S. Sanjeevan Tel: 416 754-8515	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Soil-Mat Limited Hamilton, ON Mr. J. Monkman Tel: 905 318-7400	✓	✓				✓	✓							✓	✓	✓	✓	✓
St Lawrence Testing & Inspection Co. Ltd Cornwall, ON Mr. G. McIntee Tel: 613 938-2521	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Strada Aggregates Concord, ON Mr. C. Tavernese Tel: 905 738-2200	✓	✓				✓								✓				
Sutcliffe Rody Quesnel Limited New Liskeard, ON Mr. P. Seguin Tel: 705 647-4311	✓	✓		✓		✓	✓											✓
Sutton and Associates Binbrook, ON Mr. K. MacDonald Tel: 905 692-9842	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
TCG Inc London Lab London, ON Mr. J. Srewart Tel: 519 453-5898	✓	✓				✓								✓				
Teranorth Construction & Engineering Limited Sudbury, ON Mr. E. Carriere Tel: 705 523-1540	✓	✓				✓	✓							✓				✓
Terraprobe Limited Brampton, ON Mr. K. Buth Tel: 905 796-2650	✓	✓		✓		✓	✓	✓						✓	✓	✓	✓	✓
Terraprobe Limited Barrie, ON Mr. B. Jackson Tel: 705 739-8355	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Terraprobe Limited (Mountainview) Stoney Creek, ON Mr. G. Muckle Tel: 905 643-7560	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Terraprobe Limited Sudbury Sudbury, ON Mr. R. Carniello Tel: 705 670-0460	✓	✓				✓	✓							✓	✓	✓		✓
Terraspec Engineering Peterborough, ON Mr. S. Galloway Tel: 705 743-7880	✓	✓				✓		✓						✓	✓	✓	✓	✓
Thomas Cavanagh Construction Ltd. Ashton, ON Mr. P. White Tel: 613 259-2670	✓	✓				✓								✓				
Thunder Bay Testing and Engineering Thunder Bay, ON Mr. R. Frenette Tel: 807 623-5278	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Thurber Engineering Limited Etobicoke, ON Dr. P. K. Chatterji Tel: 905 829-8666		✓				✓									✓	✓	✓	✓
Towland (London) 1970 Limited London, ON Mr. T. Martin Tel: 519 451-2750	✓	✓				✓	✓							✓				✓
Towland-Hewitson Construction Ltd. Sault Ste. Marie, ON Mr. W. Triskle Tel: 705 759-0600	✓	✓		✓		✓	✓			✓	✓	✓		✓				✓
Towland-Hewitson Construction Ltd. Thunder Bay, ON Mr. W. Triskle Tel: 807 345-2338	✓	✓				✓	✓							✓				✓
Towland-Hewitson Construction Ltd. (Mobile C2) Sault Ste. Marie, ON Mr. W. Triskle Tel: 807 345-2338	✓	✓				✓	✓							✓				✓

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Towland-Hewitson Construction Ltd. (Mobile C3) Sault Ste. Marie, ON Mr. W. Triskle Tel: 705 759-0600	✓	✓				✓								✓				✓
Towland-Hewitson Construction Ltd. (Mobile C1) Kenora, ON Mr. W. Triskle Tel: 807 548-4191	✓	✓				✓	✓							✓				✓
Trow Consulting Engineers Limited Brampton, ON Mr. F. Fregonese Tel: 905 793-9800	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Trow Consulting Engineers Limited London, ON Mr. J. Cole Tel: 519 453-1480	✓	✓				✓	✓							✓	✓	✓		✓
Trow Consulting Engineers Limited North Bay, ON Mr. P. Redmond Tel: 705 472-2220	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
Trow Consulting Engineers Limited Stoney Creek, ON Mr. C. Douglas Tel: 905 664-3300	✓	✓		✓		✓												✓
Trow Consulting Engineers Limited Sudbury, ON Mr. R. Ferguson Tel: 705 674-9681	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Trow Consulting Engineers Ltd. Thunder Bay, ON Mr. C. Baumann Tel: 807 623-9495	✓	✓		✓		✓	✓			✓	✓	✓		✓		✓		✓
TRT Sand and Gravel Limited Orono, ON Mr. P. Hill Tel: 905 983-9260	✓	✓				✓	✓							✓				
Vicdom Sand and Gravel Ltd. Uxbridge, ON Mr. B. Giordano Tel: 905 649-2193	✓	✓				✓	✓							✓				
Walker Brothers Quarries Limited Thorold, ON Mr. T. Risi Tel: 905 227-1158	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓				
Warren Bitulithic Downsview, ON Mr.B.Samulewitsch Tel: 416 633-9670	✓	✓		✓		✓	✓							✓				
Warren Bitulithic (Towland-Hewitson) Hanmer, ON Mr. W. Triskle Tel: 705 969-4461	✓	✓				✓								✓				✓
Warren Bitulithic Ltd Kitchener, ON Mr. S. Bedford Tel: 519 696-2274	✓	✓				✓	✓							✓				
Warren Paving Ltd. Cobourg, ON Mr. K. Robinson Tel: 905 372-4671	✓	✓		✓		✓	✓				✓	✓		✓				✓

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Multi-Laboratory Precision Tables
MTO Aggregate and Soil Proficiency Sample Testing Program

Test 1	1998		1999		2000		2001		ASTM C117
WP 75 µm	1.98	2.98	1 99	2.99	1 00	2 00	1.01	2 01	
Mean	3.16	3.12	2.28	2.33	0.84	0.94	0.85	0.90	<1.5
1S	0.49	0.45	0.32	0.33	0.21	0.21	0.13	0.12	0.22
D2S	1.39	1.27	0.91	0.93	0.59	0 60	0.36	0 34	0.62
n/outliers	184/13		195/8		197/4		169/35		

Test 8	1998		1999		2000		2001		ASTM C131	
L A A	1.98	2.98	1 99	2.99	1 00	2 00	1.01	2.01	C of V	σ*
Mean	23.86	24.03	27 98	28.7	51.12	51 72	24 68	24.92	10-45	24.8
1S	1.15	1.62	2.08	2 65	2 53	3 08	1 54	1.26	4 5%	1.12
D2S	3 25	4.58	5 87	7.49	7 15	8 71	4.36	3.58	12 7%	3.16
n/outliers	13/2		13/1		11/2		11/1			

Test 9	1998		1999		2000		2001		ASTM C127
BRD	1 98	2.98	1.99	2 99	1 00	2 00	1.01	2 01	
Mean	2 670	2 669	2 656	2 655	2 616	2 616	2 686	2 684	
1S	0 008	0 007	0 010	0 010	0 007	0 010	0 008	0 007	0 013
D2S	0 023	0 020	0 028	0 028	0 020	0 028	0 022	0 020	0 038
n/outliers	69/7		69/10		81/6		79/10		

Test 10	1998		1999		2000		2001		ASTM C127
ABS	1 98	2 98	1.99	2.99	1 00	2 00	1.01	2.01	
Mean	0 772	0.765	0 932	0 933	1 472	1.479	1 645	1 662	< 2 0%
1S	0 087	0 094	0 111	0 122	0 111	0 118	0 089	0 076	0.145
D2S	0.246	0.266	0.314	0 345	0 314	0 334	0 252	0 215	0 41
n/outliers	73/3		75/3		85/2		82/7		

Test 11	1998		1999		2000		2001		ASTM C88	
MgSO4	1 98	2 98	1 99	2 99	1 00	2 00	1 01	2 01	C of V	σ*
Mean	10 5	10 5	14 4	14 1	6 7	7 1	5.0	5 1	9 –20%	5.0
1S	3 9	4 5	4 4	4 6	2 3	2.2	1.9	1.9	25%	1.25
D2S	11.1	12 8	12 4	13 1	6 6	6 3	5 4	5 4	71%	3 5
n/outliers	32/0		30/1		32/0		40/1			

Test 12	1998		1999		2000		2001		MTO
% Crush	1 98	2 98	1 99	2 99	1 00	2 00	1 01	2 01	Workshop
Mean	71 6	71 4	58 9	59 3	84 7	84 8	60 0	59 7	50 – 75
1S	5 8	5 8	4 8	4 9	5 1	5 2	4 6	4 9	6 0
D2S	16 4	16 4	13 5	13 8	14 6	14 8	13 0	13 9	16 9
n/outliers	180/12		191/9		190/15		177/26		

Test 13	1998		1999		2000		2001		ASTM D 4791
% F&E	1 98	2 98	1 99	2 99	1 00	2 00	1 01	2 01	
Mean	15 1	14 9	11 2	11 3	8 8	8 6	3 3	3 5	No ASTM
1S	5 0	5 5	4 9	4 8	2 9	3 0	2 0	2 0	Precision
D2S	14 2	15 5	13 8	13.7	8 3	8 4	5.7	5 7	statements for
n/outliers	147/8		126/4		146/11		142/13		this test

Test 14	1998		1999		2000		2001		ASTM
PN Conc	1 98	2 98	1 99	2 99	1 00	2 00	1.01	2 01	
Mean	126	126	135	137	134 8	133 8	110 7	110 3	No ASTM
1S	11 4	11 5	14 8	14 8	23 1	22 1	7.5	5 9	Standard for this
D2S	32 3	32 5	41 9	41 9	65.3	62 6	21 4	16 7	test.
n/outliers	37/1		33/9		34/1		30/2		

A - AMRL reports percent passing inch series equivalent sieves

σ* - Calculated from Coefficient of Variation Precision Statement (Coefficient of Variation = standard deviation / mean)

Multi-Laboratory Precision Tables
MTO Aggregate and Soil Proficiency Sample Testing Program

Test 16	1998		1999		2000		2001		MTO LS-618
MDA. CA	1.98	2.98	1.99	2.99	1.00	2.00	1.01	2.01	
Mean	12.75	12.85	19.25	19.40	17.28	17.44	6.60	6.53	5.0
1S%	0.76	0.93	1.30	1.13	0.87	0.87	0.49	0.47	0.50
D2S%	2.18	2.64	3.68	3.19	2.46	2.47	1.40	1.35	1.41
n/outliers	42/5		42/4		51/4		60/5		

Test 17	1998		1999		2000		2001		MTO LS-614
Freeze-Thaw	1.98	2.98	1.99	2.99	1.00	2.00	1.01	2.01	
Mean	11.10	11.46	16.74	16.44	8.68	8.78	5.65	5.84	6
1S	2.34	2.46	4.26	3.81	2.27	2.32	1.53	1.47	1.2
D2S	7.01	7.39	12.05	10.78	6.44	6.57	4.33	4.17	3.5
n/outliers	35/6		33/3		41/0		49/3		

Test 2	1998		1999		2000		2001		ASTM C136[A]
P19.0 mm	1.98	2.98	1.99	2.99	1.00	2.00	1.01	2.01	
Mean	88.7	89.6	96.9	96.8	93.6	93.6	94.1	94.1	95 - 85
1S	1.7	1.6	0.8	0.8	0.9	0.9	1.1	1.0	1.37
D2S	4.8	4.5	2.3	2.3	2.7	2.8	3.1	2.8	3.9
n/outliers	195/3		199/4		198/8		207/1		

Test 3	1998		1999		2000		2001		ASTM C136[A]
P16.0 mm	1.98	2.98	1.99	2.99	1.00	2.00	1.01	2.01	
Mean	78.6	80.0	88.7	88.5	85.5	85.3	86.2	86.4	95 - 85
1S	2.0	2.0	1.1	1.4	1.1	1.3	1.3	1.2	1.37
D2S	5.6	5.6	3.1	4.0	3.3	3.8	3.7	3.4	3.9
n/outliers	192/4		189/12		199/6		204/4		

Test 4	1998		1999		2000		2001		ASTM C136[A]
P13.2 mm	1.98	2.98	1.99	2.99	1.00	2.00	1.01	2.01	
Mean	70.2	72.0	79.6	79.5	78.4	78.0	79.1	79.4	80 – 60
1S	2.3	2.1	1.4	1.7	1.3	1.5	1.5	1.3	2.82
D2S	6.6	6.0	4.0	4.8	3.7	4.2	4.3	3.8	8.0
n/outliers	194/4		192/11		201/5		201/7		

Test 5	1998		1999		2000		2001		ASTM C136[A]
P9.5 mm	1.98	2.98	1.99	2.99	1.00	2.00	1.01	2.01	
Mean	58.0	60.0	62.7	62.4	67.8	67.2	67.3	67.4	80 – 60
1S	2.3	2.3	1.2	2.2	1.3	1.5	1.5	1.3	2.82
D2S	6.6	6.6	3.4	6.1	3.6	4.3	4.2	3.9	8.0
n/outliers	195/3		189/14		199/7		200/8		

Test 6	1998		1999		2000		2001		ASTM C136[A]
P4.75 mm	1.98	2.98	1.99	2.99	1.00	2.00	1.01	2.01	
Mean	43.2	45.1	38.4	38.1	55.0	54.4	51.1	51.1	60 - 20
1S	2.1	2.0	1.3	2.2	1.4	1.5	1.4	1.4	1.97
D2S	5.9	5.7	3.6	6.2	4.0	4.3	4.0	3.9	5.6
n/outliers	193/5		191/12		200/6		197/11		

A - AMRL reports percent passing inch series equivalent sieves.

σ^* - Calculated from Coefficient of Variation Precision Statement (Coefficient of Variation = standard deviation / mean).

Multi-Laboratory Precision Tables
MTO Aggregate and Soil Proficiency Sample Testing Program

Test 20	1998		1999		2000		2001		ASTM C136[A]
P2.36 mm	3.98	4.98	3.99	4.99	3.00	4.00	3.01	4.01	
Mean	33.0	34.4	25.4	25.2	47.0	46.6	41.8	41.9	60 - 20
1S	2.0	2.2	1.5	1.9	1.4	1.6	1.5	1.6	1.41
D2S	5.5	6.1	4.2	5.4	4.0	4.6	4.3	4.5	4.0
n/outliers	193/4		195/7		200/5		194/14		

Test 21	1998		1999		2000		2001		ASTM C136[A]
P1.18 mm	3.98	4.98	3.99	4.99	3.00	4.00	3.01	4.01	
Mean	23.7	24.7	17.8	17.7	40.1	39.5	34.1	34.3	60 - 20
1S	1.8	1.9	1.4	1.5	1.6	1.7	1.7	1.8	1.41
D2S	5.2	5.5	3.9	4.2	4.6	4.9	4.9	5.2	4.0
n/outliers	193/5		192/11		201/4		198/10		

Test 22	1998		1999		2000		2001		ASTM C136[A]
P600 µm	3.98	4.98	3.99	4.99	3.00	4.00	3.01	4.01	
Mean	16.9	17.6	13.7	13.6	31.0	30.6	25.4	25.6	60 - 20
1S	1.5	1.6	1.1	1.3	1.6	1.7	1.6	1.6	1.41
D2S	4.3	4.4	3.1	3.6	4.6	4.7	4.6	4.6	4.0
n/outliers	190/7		189/13		196/9		197/11		

Test 23	1998		1999		2000		2001		ASTM C136[A]
P300 µm	3.98	4.98	3.99	4.99	3.00	4.00	3.01	4.01	
Mean	12.6	13.0	11.2	11.1	19.1	18.8	14.0	14.2	20 - 15
1S	1.0	1.2	0.9	1.1	1.4	1.2	0.9	0.9	1.10
D2S	2.9	3.4	2.6	3.2	4.0	3.4	2.7	2.7	3.1
n/outliers	184/14		191/12		198/7		191/17		

Test 24	1998		1999		2000		2001		ASTM C136[A]
P150 µm	3.98	4.98	3.99	4.99	3.00	4.00	3.01	4.01	
Mean	8.9	9.1	9.4	9.4	9.2	9.1	7.7	7.8	10 - 2
1S	0.7	0.9	0.8	1.0	0.8	0.7	0.5	0.5	0.65
D2S	2.0	2.5	2.1	2.8	2.5	2.2	1.3	1.5	1.8
n/outliers	183/14		187/15		201/4		189/19		

Test 25	1998		1999		2000		2001		ASTM C136[A]
P75 µm	3.98	4.98	3.99	4.99	3.00	4.00	3.01	4.01	
Mean	6.3	6.5	8.0	8.1	4.5	4.4	5.3	5.4	10 - 2
1S	0.5	0.6	0.7	0.8	0.5	0.5	0.4	0.4	0.65
D2S	1.5	1.7	1.8	2.3	1.4	1.3	1.1	1.1	1.8
n/outliers	179/19		187/16		201/4		193/15		

Test 27	1998		1999		2000		2001		ASTM C128
BRD	3.98	4.98	3.99	4.99	3.00	4.00	3.01	4.01	
Mean	2.654	2.652	2.589	2.589	2.699	2.700	2.654	2.652	
1S	0.021	0.019	0.017	0.020	0.017	0.017	0.013	0.015	0.023
D2S	0.059	0.054	0.048	0.057	0.048	0.048	0.036	0.042	0.066
n/outliers	67/6		69/7		72/8		78/7		

Test 28	1998		1999		2000		2001		ASTM C128
ABS	3.98	4.98	3.99	4.99	3.00	4.00	3.01	4.01	
Mean	0.868	0.885	1.74	1.73	0.65	0.65	0.76	0.78	< 1.0%
1S	0.20	0.21	0.33	0.36	0.19	0.20	0.16	0.19	0.23
D2S	0.57	0.60	0.93	1.02	0.55	0.58	0.47	0.53	0.66
n/outliers	67/7		70/6		76/4		78/7		

Test 29	1998		1999		2000		2001		ASTM C88
MgSO4	3.98	4.98	3.99	4.99	3.00	4.00	3.01	4.01	
Mean	8.8	9.2	22.8	22.6	13.0	12.6	8.3	8.3	ASTM precision
1S	3.7	3.4	9.4	8.6	4.7	4.7	3.5	3.3	statements for
D2S	10.4	9.5	26.6	24.4	13.3	13.3	9.8	9.3	coarse aggregate
n/outliers	26/0		25/0		27/0		33/2		only

A - AMRL reports percent passing inch series equivalent sieves.
σ* - Calculated from Coefficient of Variation Precision Statement (Coefficient of Variation = standard deviation / mean)

Multi-Laboratory Precision Tables
MTO Aggregate and Soil Proficiency Sample Testing Program

Test 30	2001								MTO LS-621
% ACP	1.01	2.01							
Mean	29.8	29.7							No MTO Precision Statements for This test.
1S	2.8	2.9							
D2S	8.1	8.3							
n/outliers	190/12								

Test 31	1998		1999		2000		2001		ASTM D698
MWD	3.98	4.98	3.99	4.99	3.00	4.00	3.01	4.01	
Mean	2.345	2.346	2.332	2.331	2.371	2.374	2.248	2.249	No ASTM precision statements for this test
1S	0.028	0.030	0.030	0.029	0.039	0.037	0.028	0.026	
D2S	0.079	0.085	0.085	0.082	0.110	0.104	0.079	0.073	
n/outliers	90/6		104/6		125/3		127/17		

Test 32	1998		1999		2000		2001		ASTM D698
MDD	3.98	4.98	3.99	4.99	3.00	4.00	3.01	4.01	
Mean	2.179	2.181	2.163	2.160	2.214	2.214	2.066	2.066	No ASTM precision statements for this test
1S	0.028	0.032	0.032	0.035	0.034	0.033	0.028	0.029	
D2S	0.079	0.091	0.091	0.099	0.096	0.093	0.079	0.082	
n/outliers	91/5		106/4		121/7		129/15		

Test 33	1998		1999		2000		2001		ASTM D698
OMC	3.98	4.98	3.99	4.99	3.00	4.00	3.01	4.01	
Mean	7.57	7.58	7.83	7.87	7.36	7.41	8.89	8.88	No ASTM precision statements for this test.
1S	0.38	0.34	0.42	0.43	0.30	0.30	0.51	0.55	
D2S	1.07	0.97	1.19	1.22	0.86	0.87	1.43	1.57	
n/outliers	90/6		107/3		117/11		133/10		

Test 34	1998		1999		2000		2001		MTO LS-619
MDA FA	3.98	4.98	3.99	4.99	3.00	4.00	3.01	4.01	
Mean	11.1	10.9	30.0	29.8	7.6	7.5	11.1	11.1	10.5
1S	1.3	1.4	3.1	3.4	1.0	1.1	0.9	0.9	0.6
D2S	3.7	4.0	8.8	9.6	3.0	3.2	2.7	2.6	1.8
n/outliers	41/6		45/1		54/2		62/2		

Test 40	1998		1999		2000		2001		ASTM D422
P2.0 mm	5.98	6.98	5.99	6.99	5.00	6.00	5.01	6.01	
Mean	100.0	100.0	100.0	100.0	100.0	100.0	99.9	99.9	No ASTM precision statements for this test.
1S							0.08	0.06	
D2S							0.25	0.17	
n/outliers	65/0		69/0		55/8		69/18		

Test 41	1998		1999		2000		2001		ASTM D422
P425 µm	5.98	6.98	5.99	6.99	5.00	6.00	5.01	6.01	
Mean	96.6	96.7	96.5	96.8	98.5	98.4	96.3	96.3	No ASTM precision statements for this test
1S	0.5	0.6	0.9	0.9	0.5	0.5	0.3	0.5	
D2S	1.4	1.6	2.5	2.5	1.4	1.5	0.9	1.5	
n/outliers	59/6		64/6		59/4		65/22		

Test 42	1998		1999		2000		2001		ASTM D422
P75 µm	5.98	6.98	5.99	6.99	5.00	6.00	5.01	6.01	
Mean	90.6	90.9	90.7	90.8	92.7	92.6	88.6	88.7	No ASTM precision statements for this test
1S	1.0	0.8	0.9	0.9	0.8	0.7	0.5	0.5	
D2S	2.9	2.3	2.5	2.5	2.3	2.2	1.4	1.4	
n/outliers	57/8		61/9		56/7		62/25		

A - AMRL reports percent passing inch series equivalent sieves

σ* - Calculated from Coefficient of Variation Precision Statement (Coefficient of Variation = standard deviation / mean).

Multi-Laboratory Precision Tables
MTO Aggregate and Soil Proficiency Sample Testing Program

Test 43	1998		1999		2000		2001		ASTM D422
P20 µm	5.98	6.98	5.99	6.99	5.00	6.00	5.01	6.01	
Mean	78.1	78.3	77.5	77.5	62.6	62.7	69.6	69.8	No ASTM
1S	4.3	4.4	4.0	3.9	4.5	5.1	4.0	3.8	precision
D2S	12.1	12.6	11.4	11.1	12.8	14.5	11.4	10.7	statements for this
n/outliers	63/2		65/4		60/3		68/19		test

Test 44	1998		1999		2000		2001		ASTM D422
P5 µm	5.98	6.98	5.99	6.99	5.00	6.00	5.01	6.01	
Mean	56.7	57.0	56.1	56.7	45.3	45.4	43.8	44.0	No ASTM
1S	5.4	5.4	3.2	3.2	4.8	5.0	3.2	2.9	precision
D2S	15.2	15.2	9.0	9.0	13.6	14.3	9.1	8.2	statements for this
n/outliers	63/2		60/9		61/2		66/21		test

Test 45	1998		1999		2000		2001		ASTM D422
P2 µm	5.98	6.98	5.99	6.99	5.00	6.00	5.01	6.01	
Mean	41.8	41.8	41.5	41.6	34.6	34.7	30.9	30.9	NO ASTM
1S	5.0	5.5	3.1	2.9	3.9	4.4	2.7	2.9	Precision
D2S	14.2	15.5	8.8	8.3	11.1	12.5	7.6	8.2	Statements for
n/outliers	64/1		57/11		59/4		66/21		This test

Test 46	1998		1999		2000		2001		ASTM D4318
L.L	5.98	6.98	5.99	6.99	5.00	6.00	5.01	6.01	
Mean	36.77	37.26	36.91	36.95	34.6	34.6	27.3	27.3	33.3
1S	2.04	2.26	1.59	1.62	2.00	1.93	1.18	1.18	0.8
D2S	5.77	6.40	4.49	4.59	5.66	5.46	3.34	3.36	2
n/outliers	64/4		68/9		74/0		74/7		

Test 47	1998		1999		2000		2001		ASTM D4318
P.L	5.98	6.98	5.99	6.99	5.00	6.00	5.01	6.01	
Mean	18.86	19.30	18.85	19.10	17.6	17.8	15.3	15.4	19.9
1S	1.59	1.64	1.87	1.66	1.76	1.75	1.01	0.98	1.3
D2S	4.50	4.64	5.29	4.70	5.00	4.94	2.86	2.78	4
n/outliers	67/1		73/4		74/0		76/5		

Test 48	1998		1999		2000		2001		ASTM D4318
P.I	5.98	6.98	5.99	6.99	5.00	6.00	5.01	6.01	
Mean	17.69	17.82	17.79	17.56	16.8	16.6	12.2	12.1	13.4
1S	2.65	2.72	2.19	2.38	2.26	2.33	1.69	1.74	1.6
D2S	7.50	7.70	6.22	6.72	6.39	6.60	4.79	4.92	4
n/outliers	66/2		72/5		73/1		79/2		

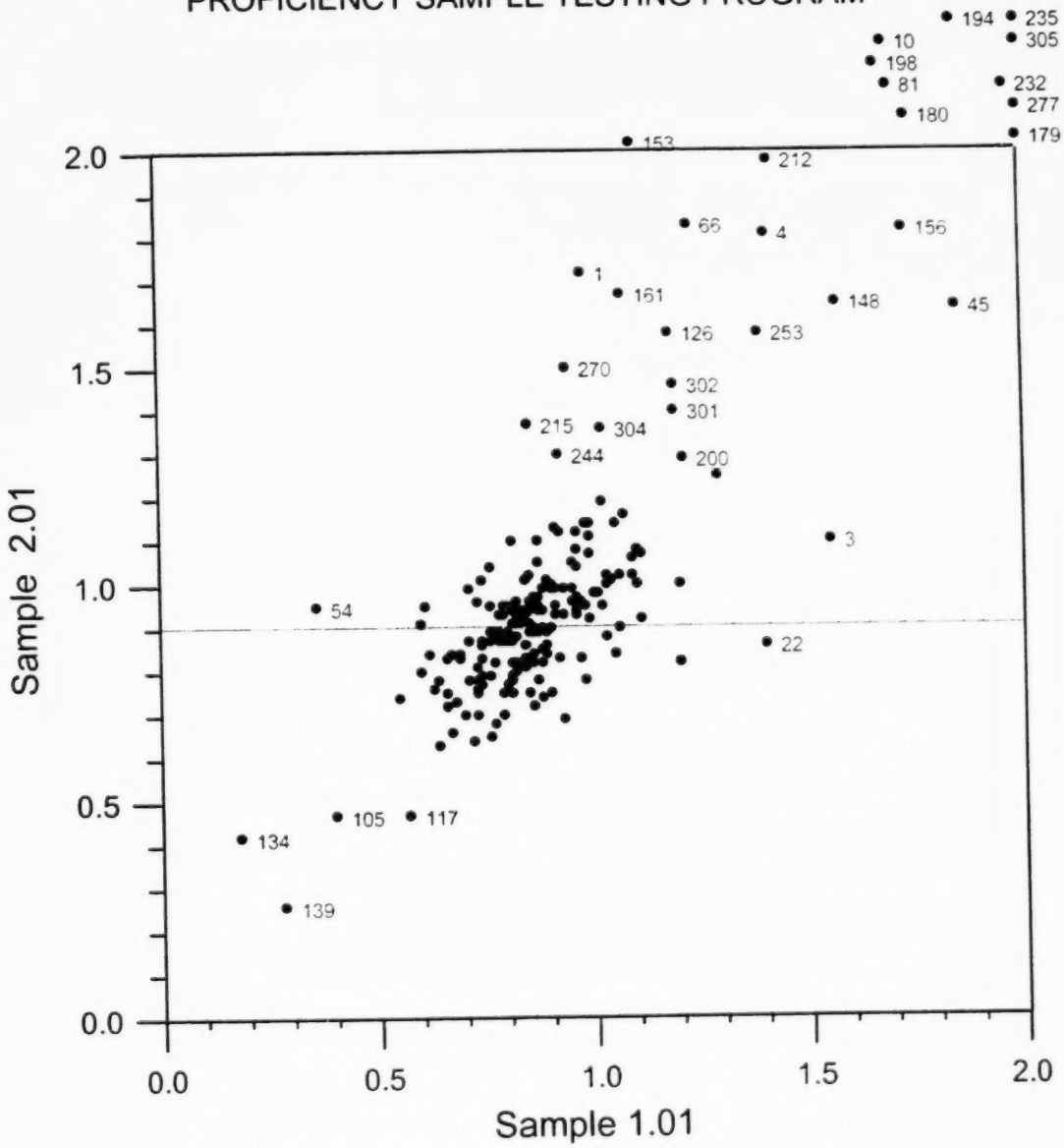
Test 49	1998		1999		2000		2001		ASTM D854
Dr	5.98	6.98	5.99	6.99	5.00	6.00	5.01	6.01	
Mean	2.687	2.688	2.705	2.704	2.689	2.691	2.720	2.725	
1S	0.079	0.078	0.041	0.040	0.057	0.054	0.026	0.025	0.041
D2S	0.223	0.221	0.116	0.113	0.161	0.152	0.073	0.071	0.12
n/outliers	41/3		44/0		42/1		55/8		

A - AMRL reports percent passing inch series equivalent sieves.

σ* - Calculated from Coefficient of Variation Precision Statement (Coefficient of Variation = standard deviation / mean)

Scatter Diagrams

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

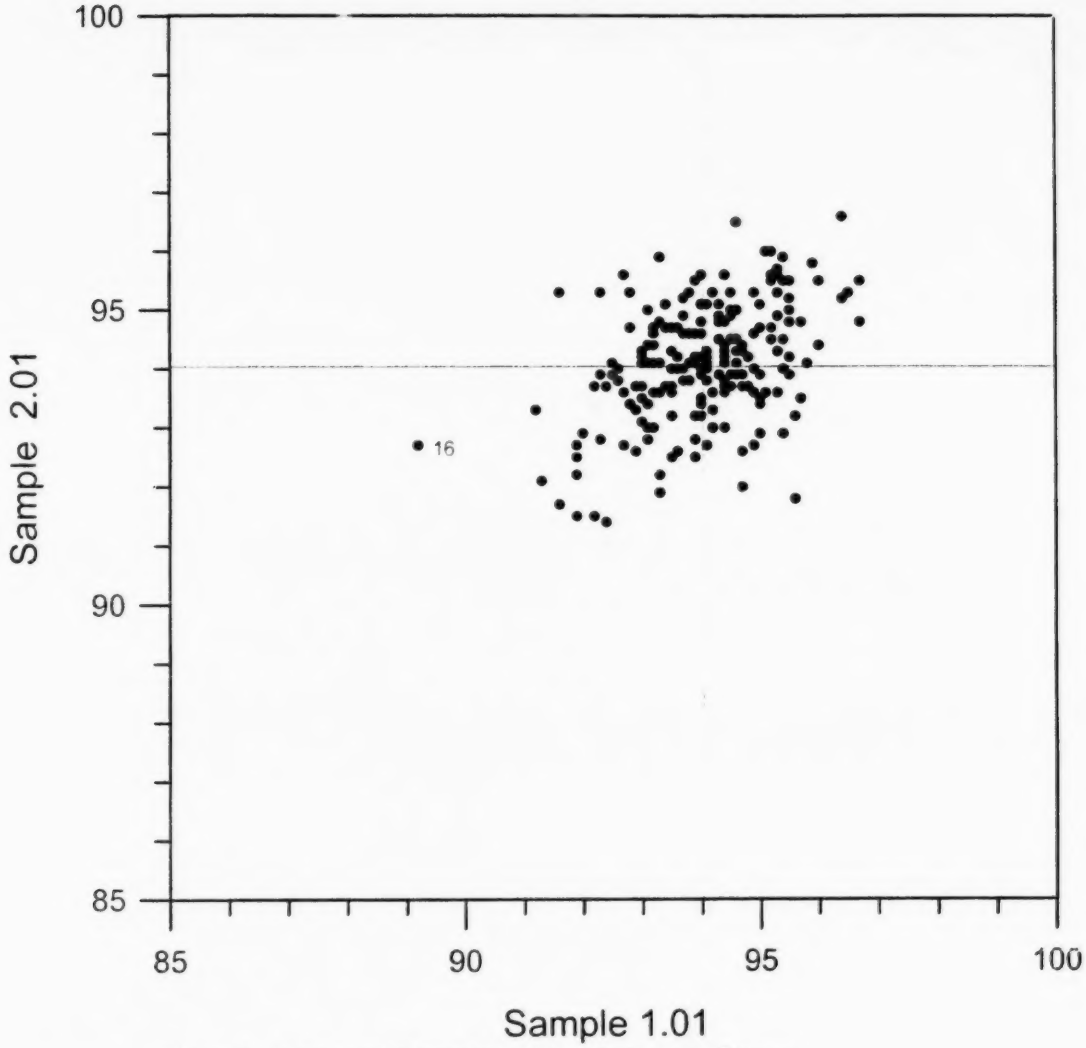


Test 1: Wash Pass 75 um

	Mat 1	Mat 2
Mean	0.856	0.903
Median	0.850	0.910
Std Dev	0.129	0.120
n = 169		

Labs Eliminated: 1, 3, 4, 10, 22, 45, 54, 66, 81, 105, 117, 126, 134, 139, 148, 153, 156, 161, 179, 180, 194, 198, 200, 212, 215, 232, 235, 244, 253, 270, 277, 301, 302, 304, 305

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

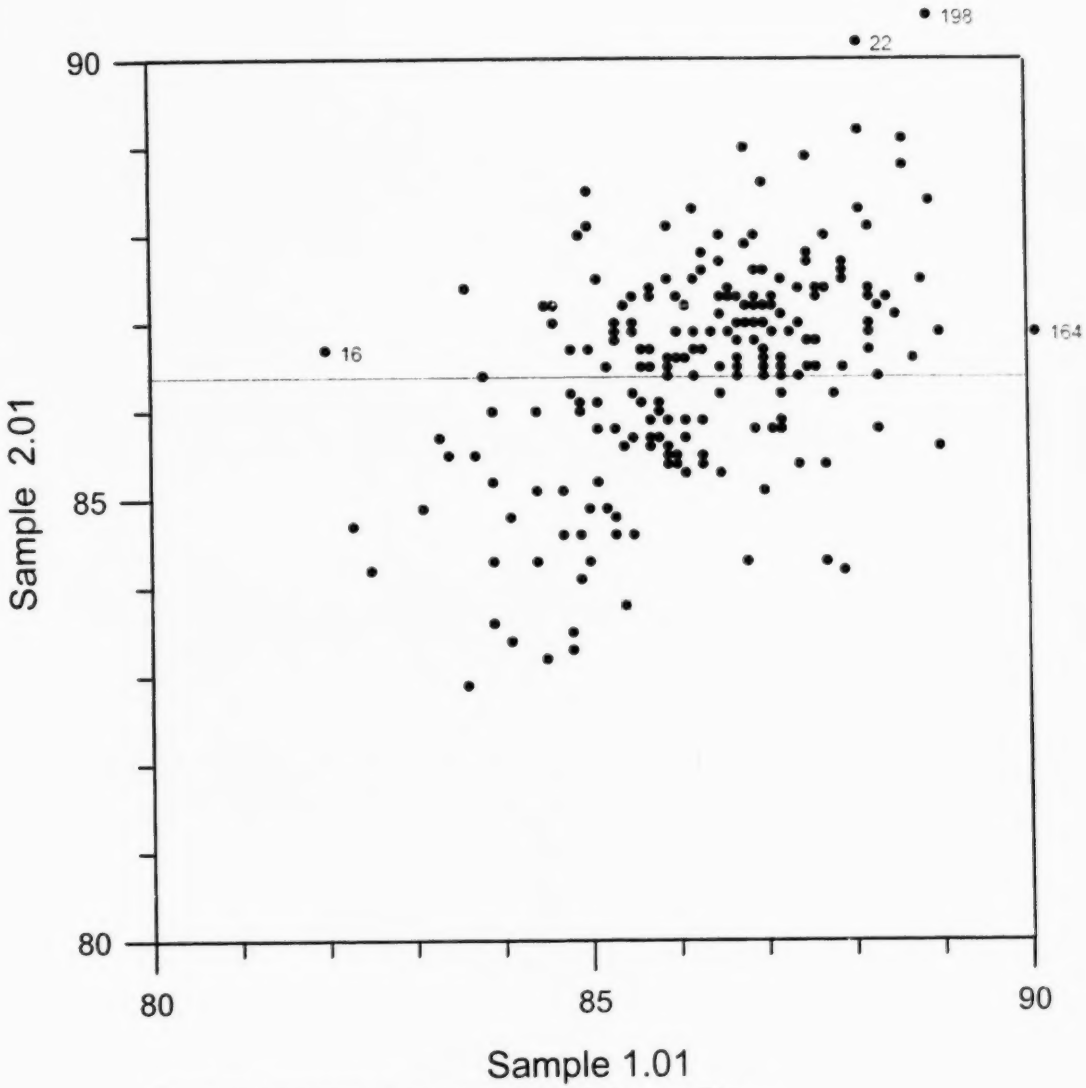


Test 2: Percent Passing the 19.0 mm Sieve

	Mat 1	Mat 2
Mean	94.071	94.140
Median	94.100	94.100
Std Dev	1.084	0.994
n = 207		

Lab Eliminated: 16

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

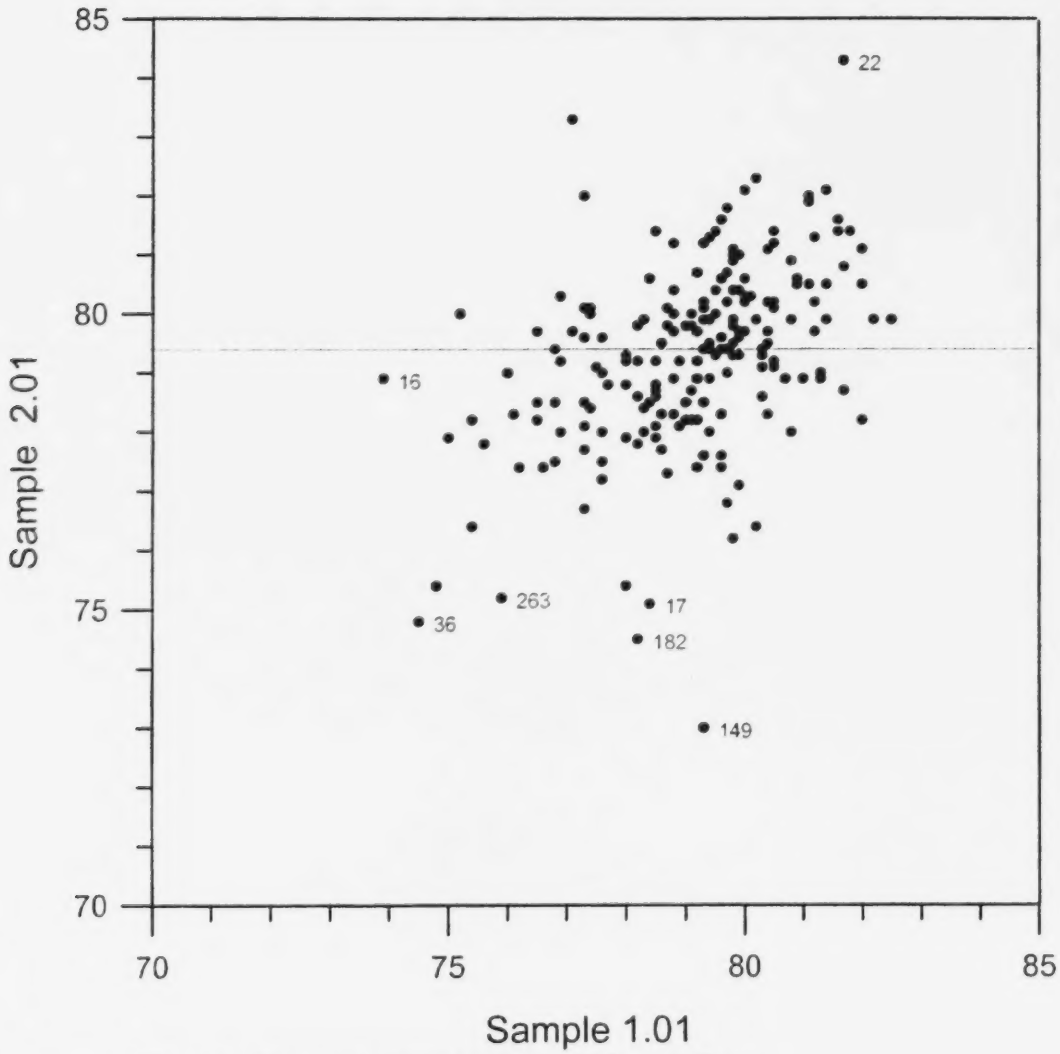


Test 3: Percent Passing the 16.0 mm Sieve

	Mat 1	Mat 2
Mean	86.263	86.450
Median	86.300	86.600
Std Dev	1.328	1.192
n = 204		

Labs Eliminated: 16, 22, 164, 198

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

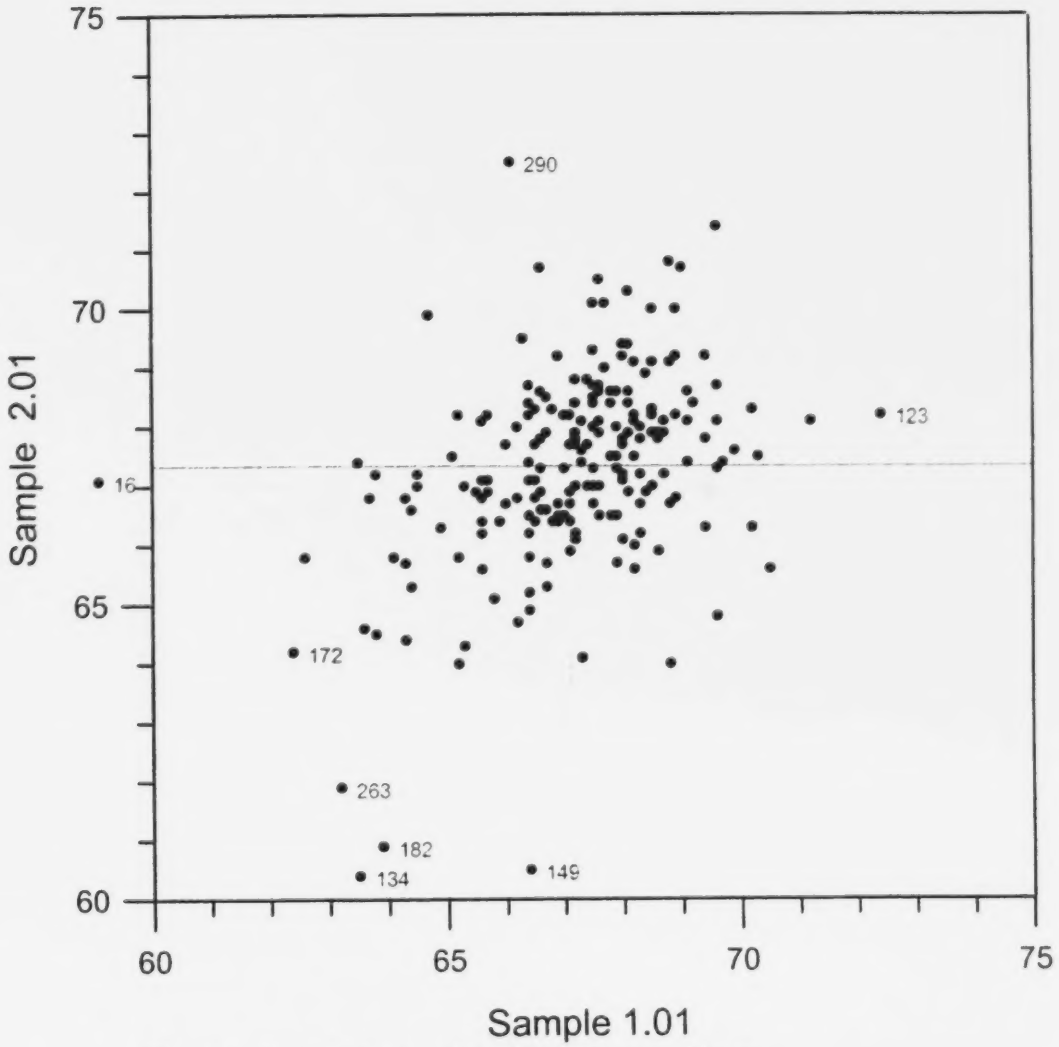


Test 4: Percent Passing the 13.2 mm Sieve

	Mat 1	Mat 2
Mean	79.156	79.405
Median	79.400	79.400
Std Dev	1.515	1.347
n = 201		

Labs Eliminated: 16, 17, 22, 36, 149, 182, 263

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

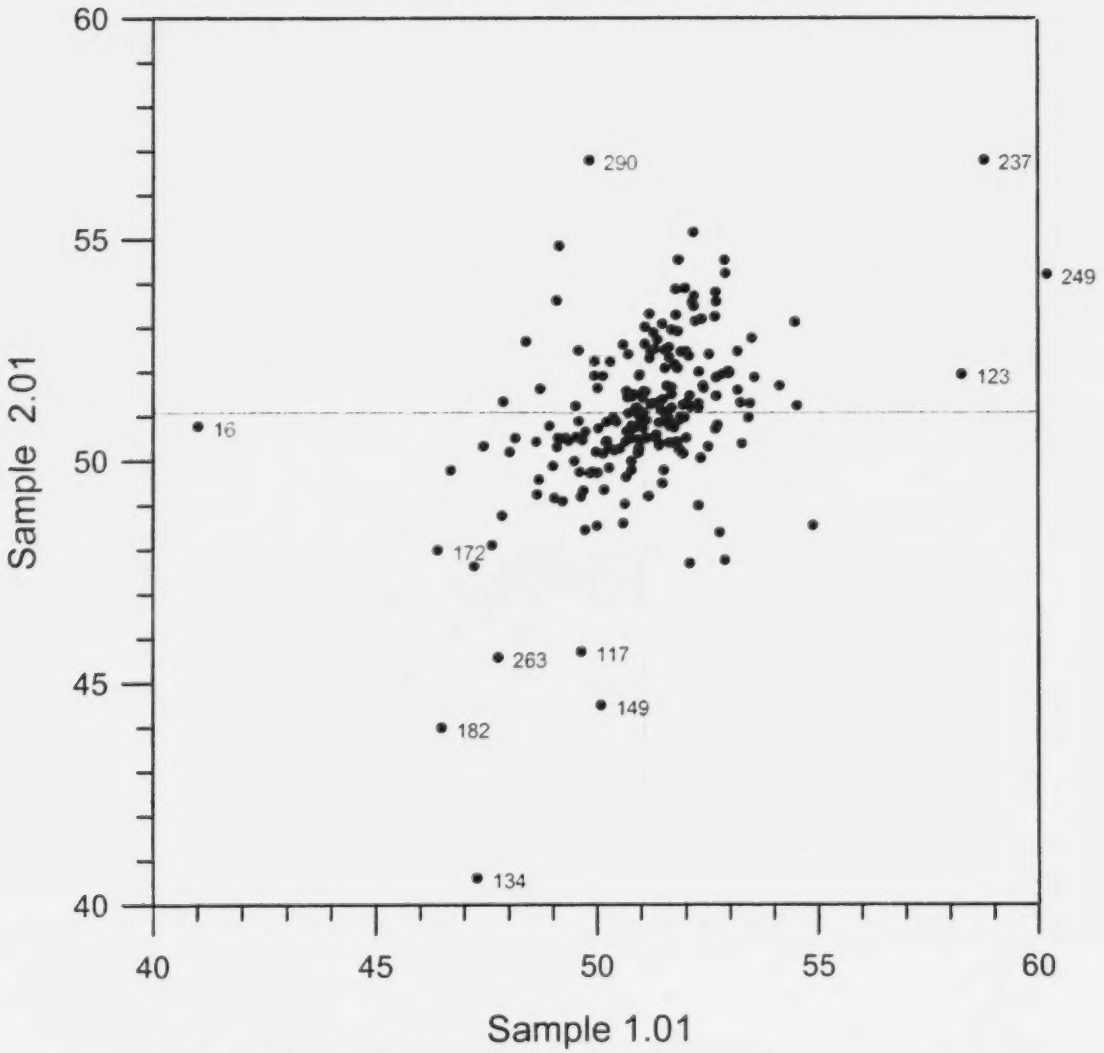


Test 5: Percent Passing the 9.5 mm Sieve

	Mat 1	Mat 2
Mean	67.268	67.424
Median	67.500	67.400
Std Dev	1.493	1.368
n = 200		

Labs Eliminated: 16, 123, 134, 149, 172, 182, 263, 290

2001MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

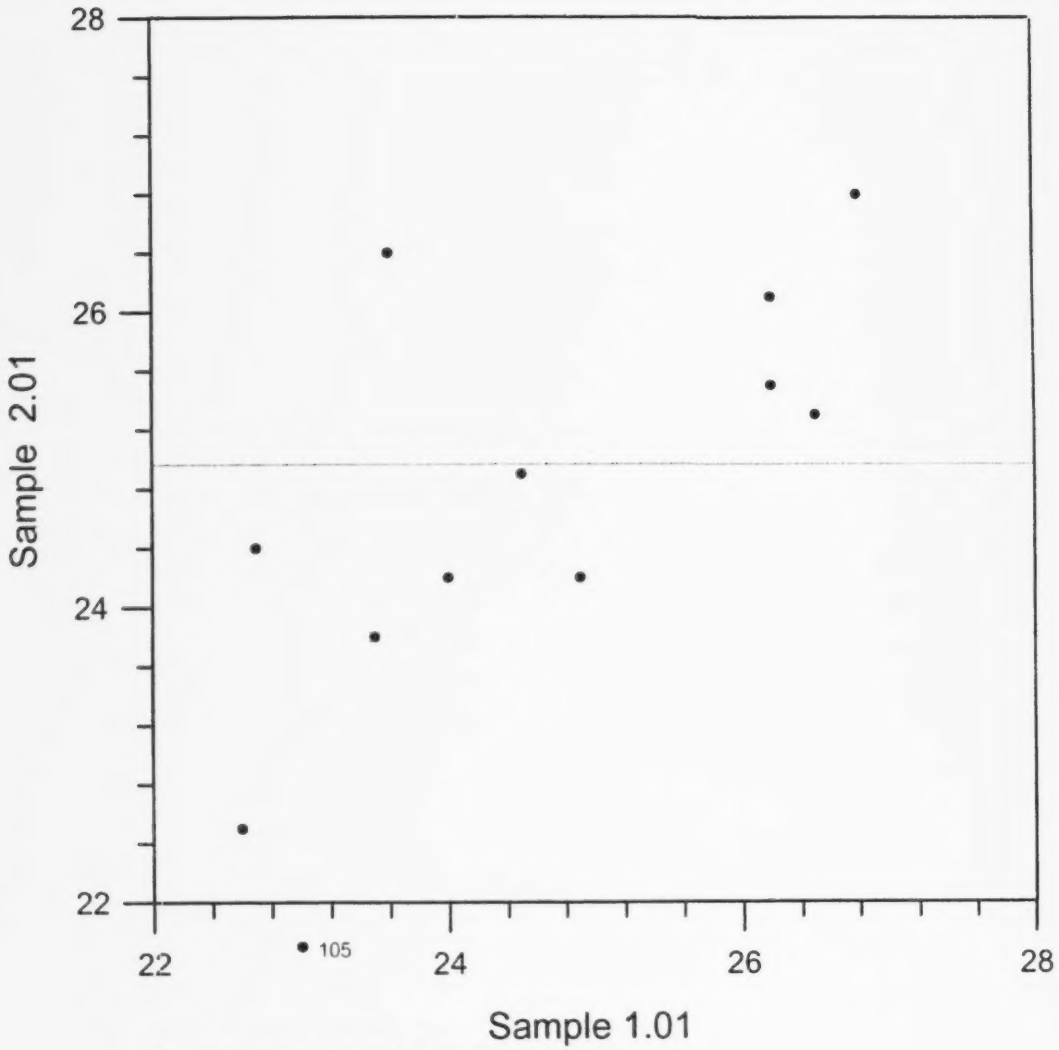


Test 6: Percent Passing the 4.75 mm Sieve

	Mat 1	Mat 2
Mean	51.113	51.168
Median	51.230	51.000
Std Dev	1.422	1.395
n = 197		

Labs Eliminated: 16, 117, 123, 134, 149, 172, 182, 237, 249, 263, 290,

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

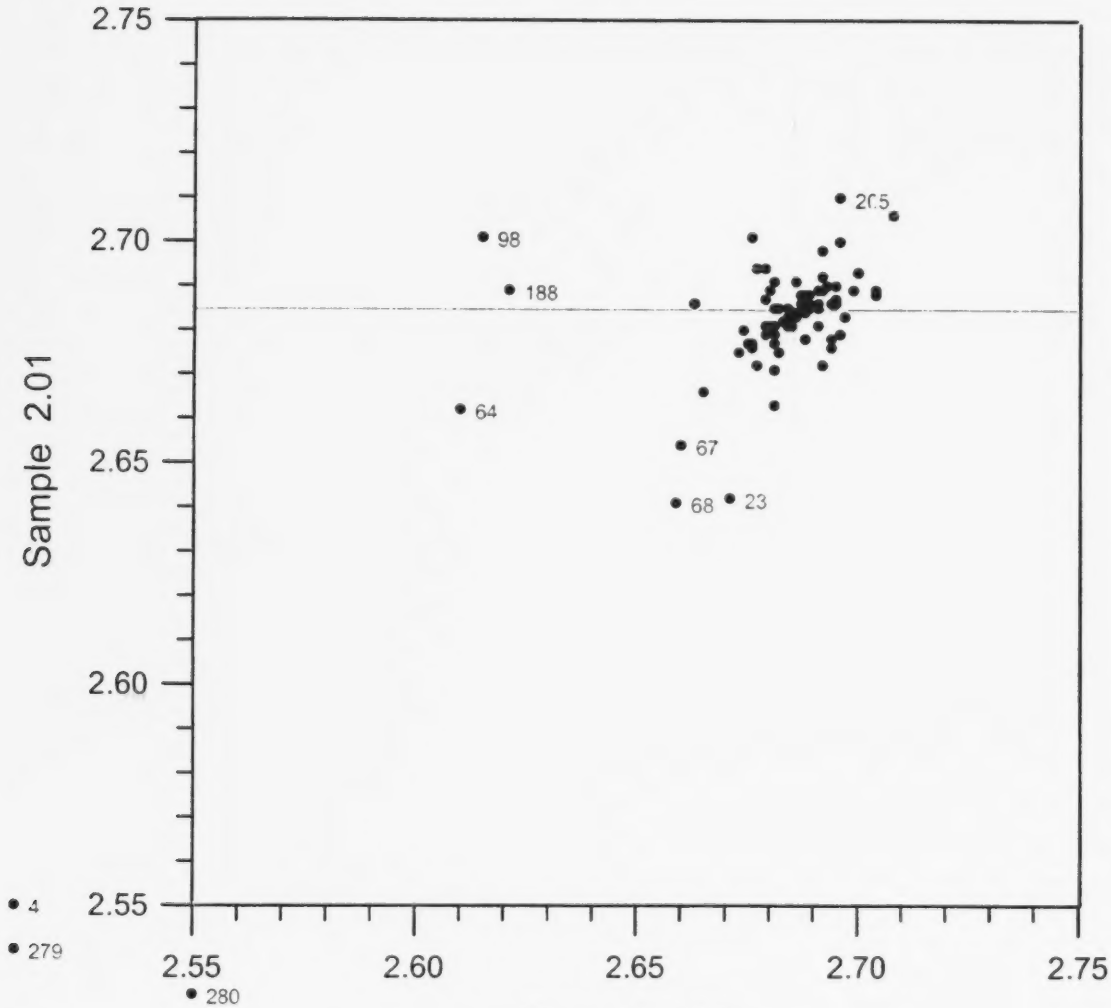


Test 8: Los Angeles Abrasion Loss, %

	Mat 1	Mat 2
Mean	24.682	24.918
Median	24.500	24.900
Std Dev	1.542	1.266
n = 11		

Lab Eliminated: 105

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

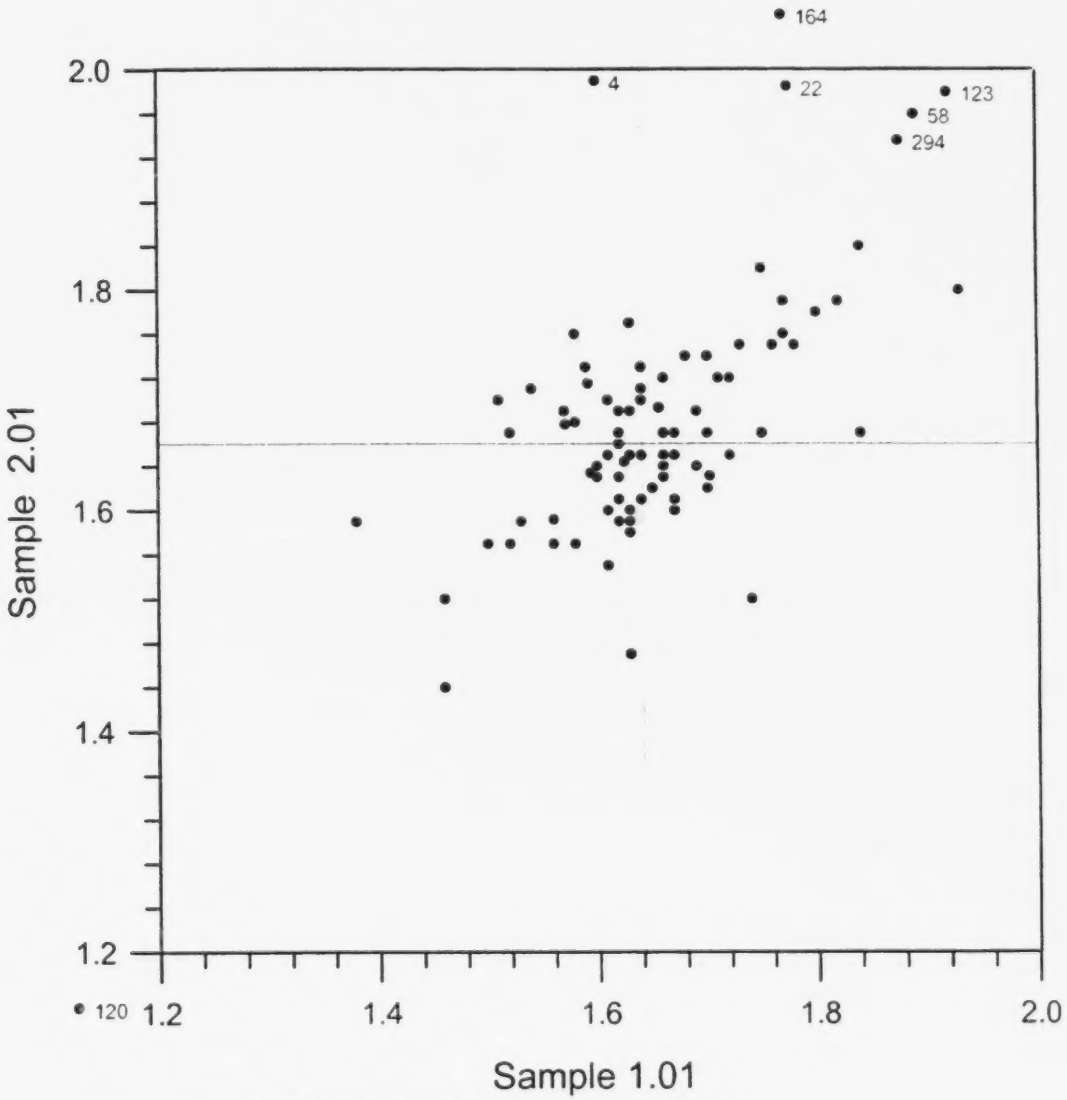


Test 9: Relative Density (Coarse Aggregate - Bulk)

	Mat 1	Mat 2
Mean	2.686	2.684
Median	2.686	2.684
Std Dev	0.008	0.007
n = 79		

Labs Eliminated: 4, 23, 64, 67, 68, 98, 188,205, 279, 280

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

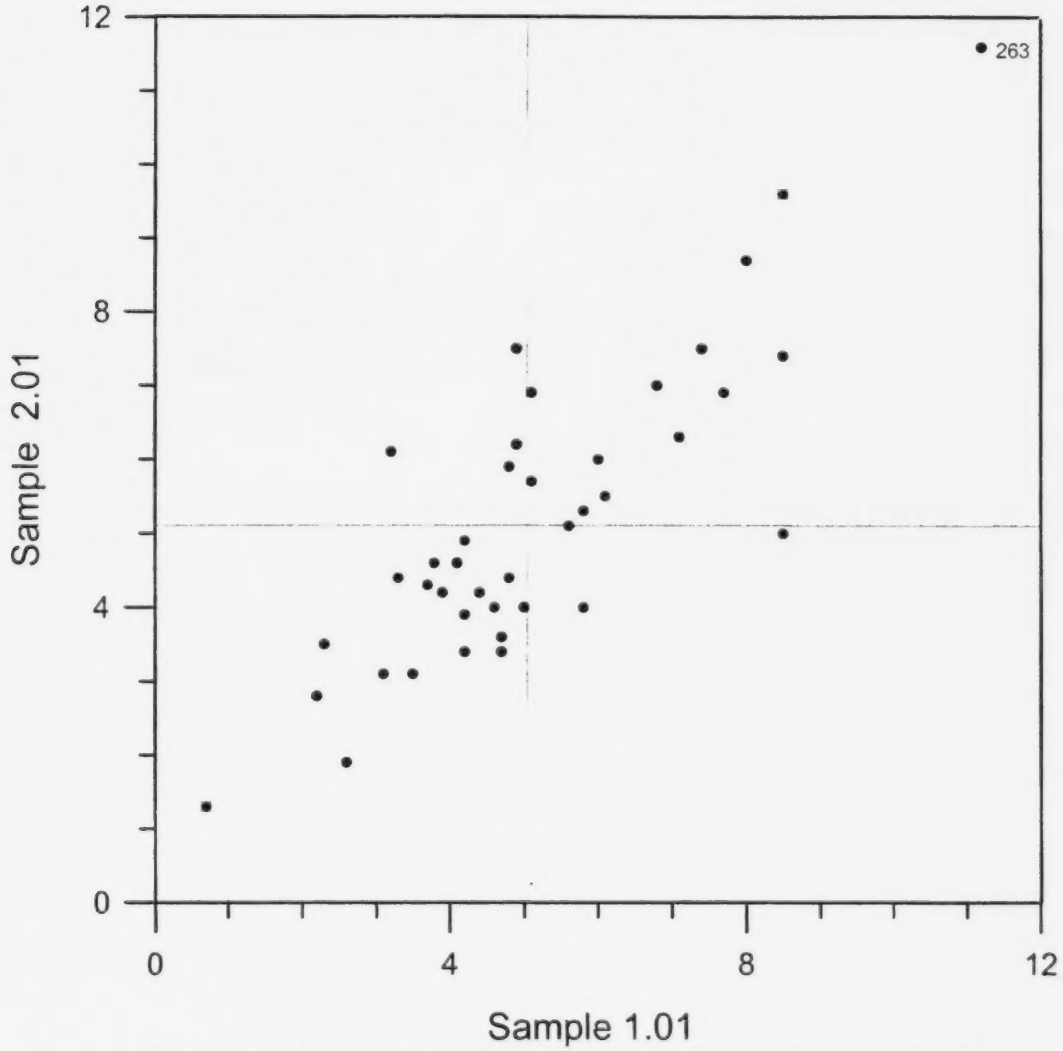


Test 10: Absorption (Coarse Aggregate)

	Mat 1	Mat 2
Mean	1.645	1.662
Median	1.635	1.665
Std Dev	0.089	0.076
n = 82		

Labs Eliminated: 4, 22, 58, 120, 123, 164, 294

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

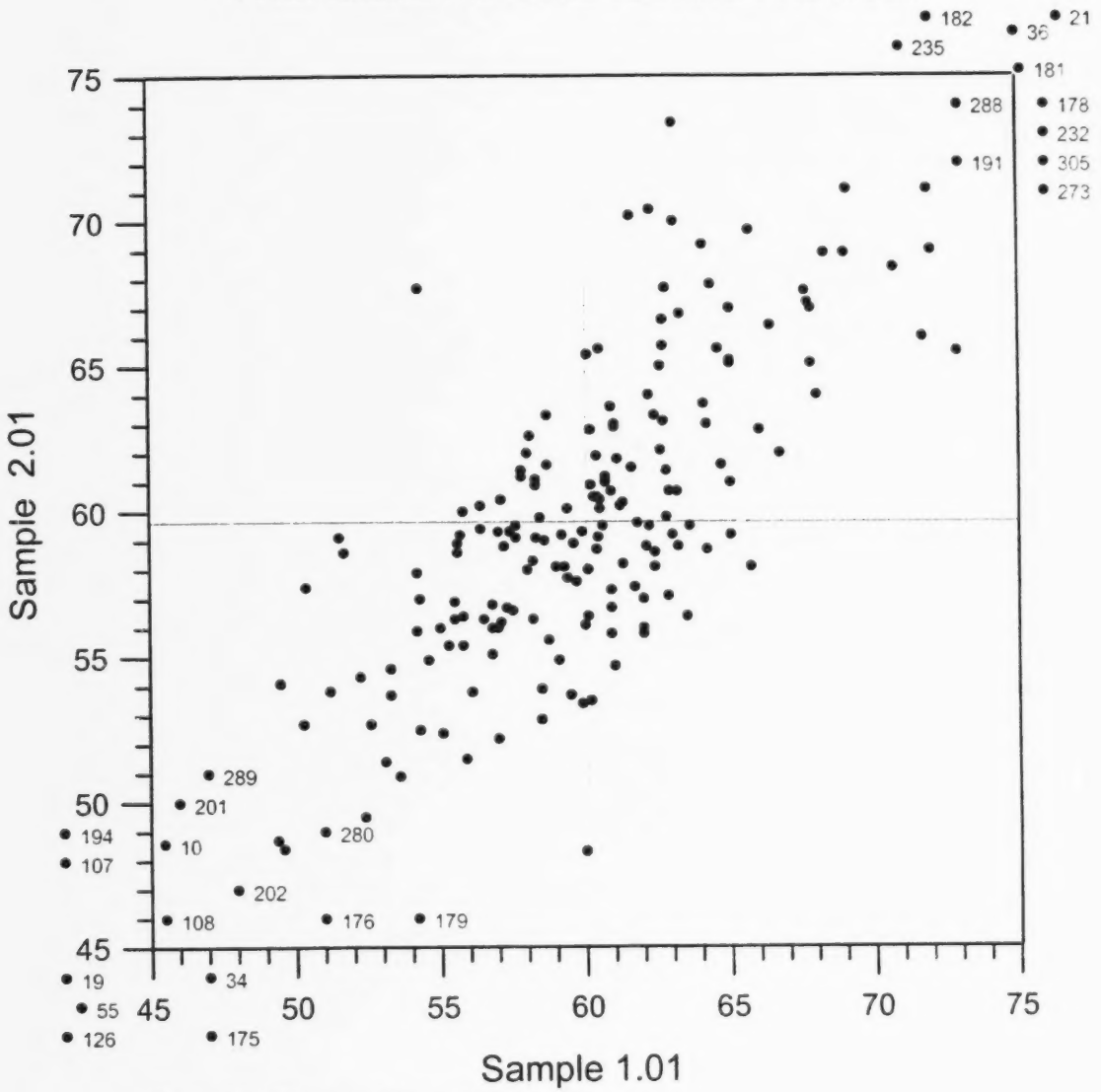


Test 11: MgSO4 Soundness (Coarse Aggregate), % Loss

	Mat 1	Mat 2
Mean	5.057	5.145
Median	4.800	4.750
Std Dev	1.906	1.917
n = 40		

Lab Eliminated: 263

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

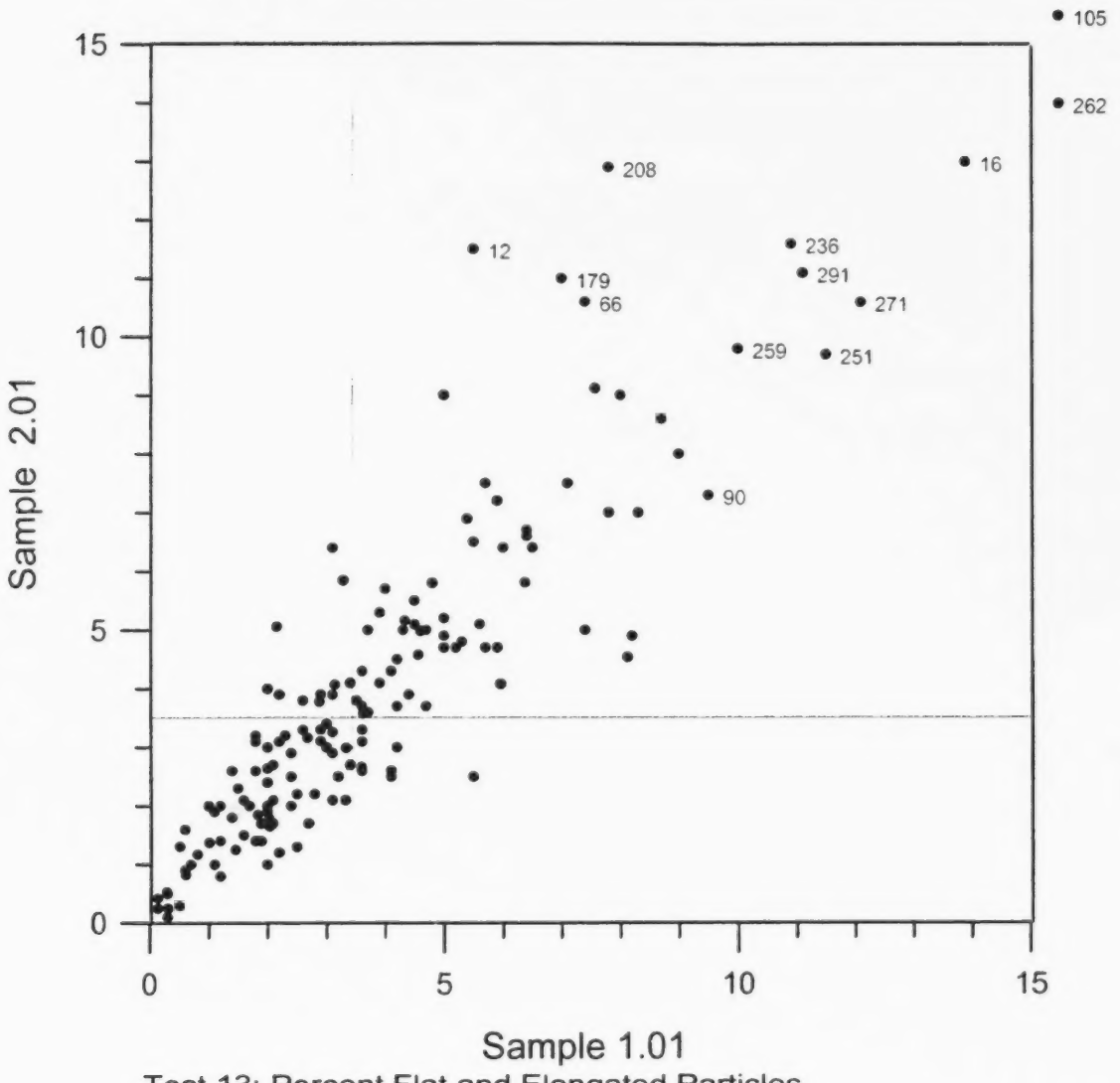


Test 12: Percent Crushed Particles

	Mat 1	Mat 2
Mean	60.047	59.741
Median	60.200	59.200
Std Dev	4.601	4.941
n = 177		

Labs Eliminated: 10, 19, 21, 34, 36, 55, 107, 108, 126, 175, 176, 178, 179, 181, 182, 191, 194, 201, 202, 232, 235, 273, 280, 288, 289, 305

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

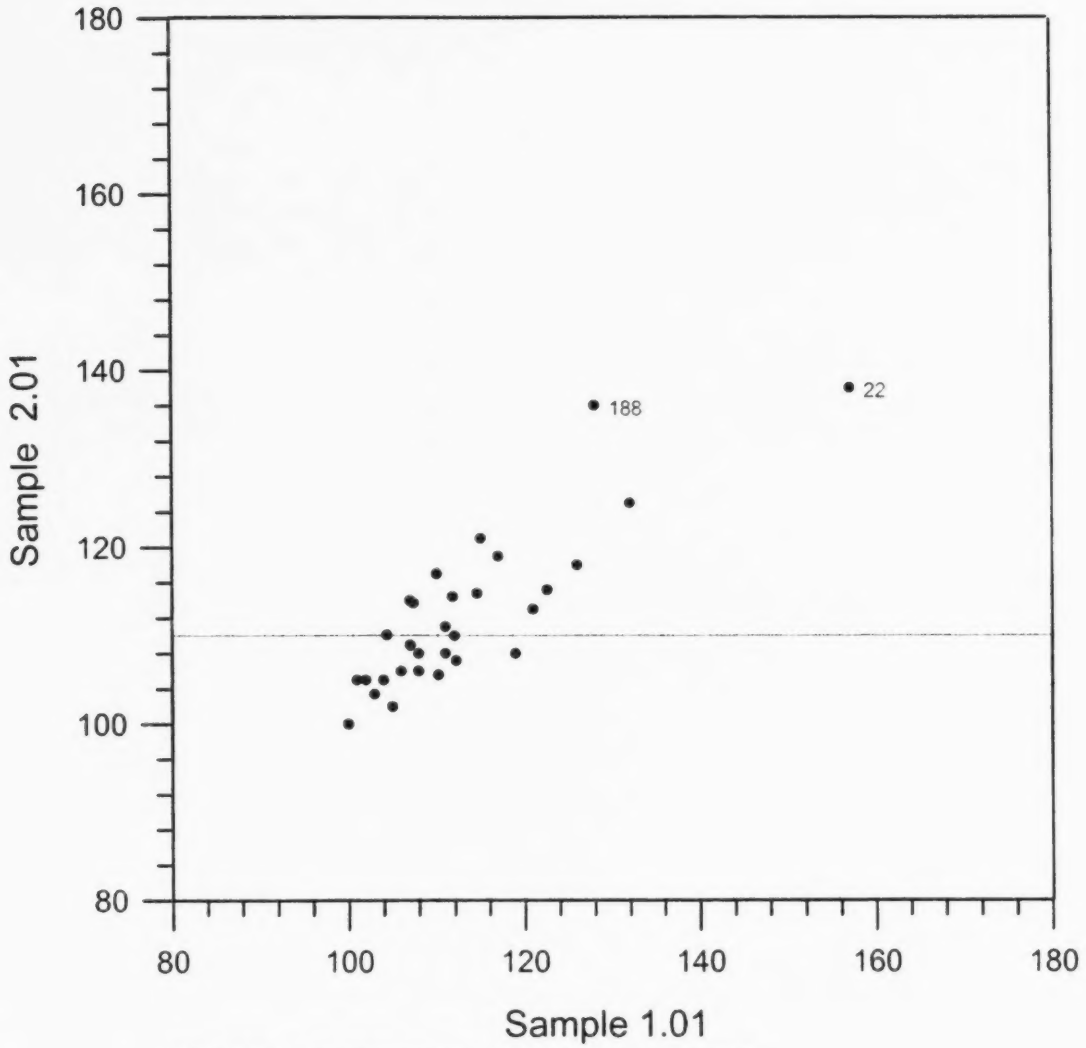


Test 13: Percent Flat and Elongated Particles

	Mat 1	Mat 2
Mean	3.347	3.489
Median	3.050	3.105
Std Dev	2.025	2.021
n = 142		

Labs Eliminated: 12, 16, 66, 90, 105, 179, 208, 236, 251, 259, 262, 271, 291

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

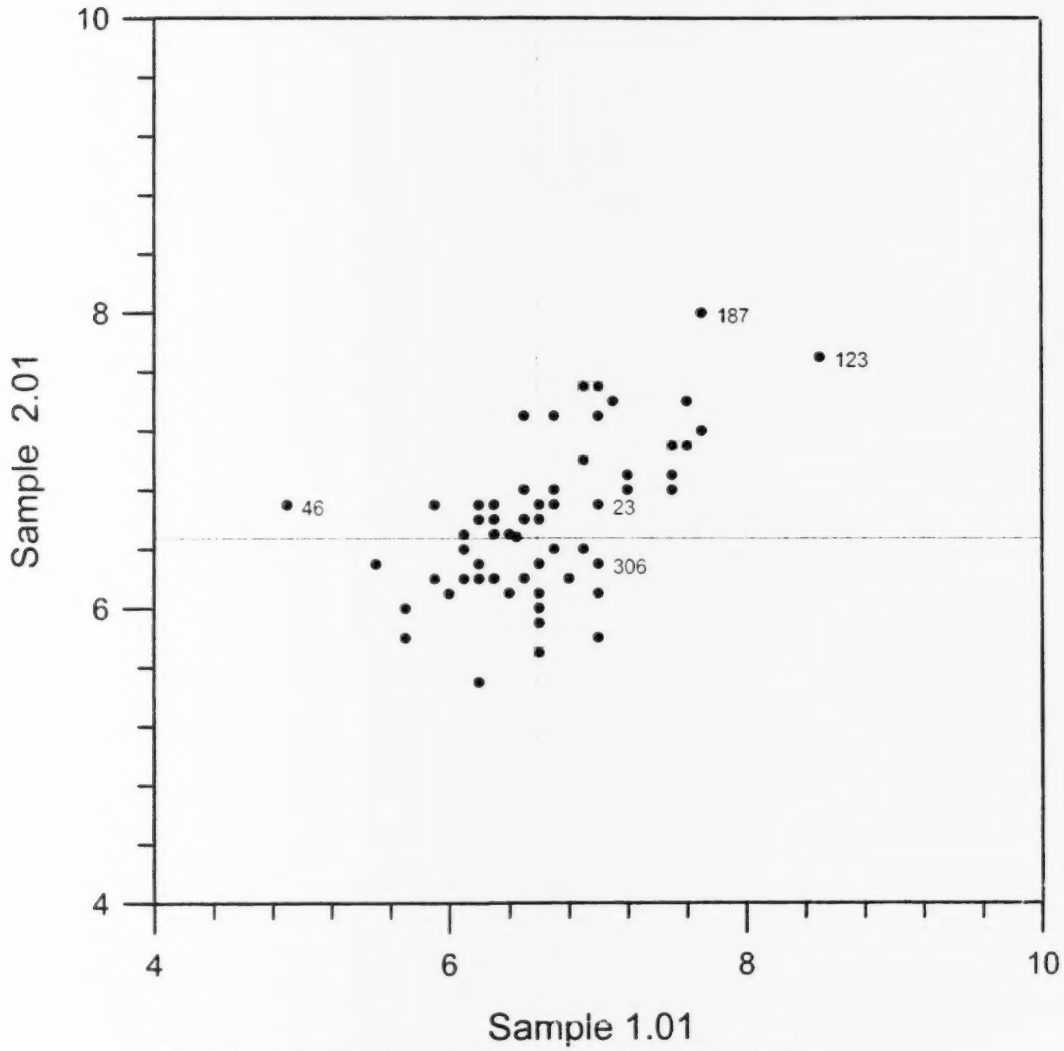


Test 14: Petrographic Number (Concrete)

	Mat 1	Mat 2
Mean	110.710	110.310
Median	109.000	108.950
Std Dev	7.553	5.925
n = 30		

Labs Eliminated: 22, 188

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

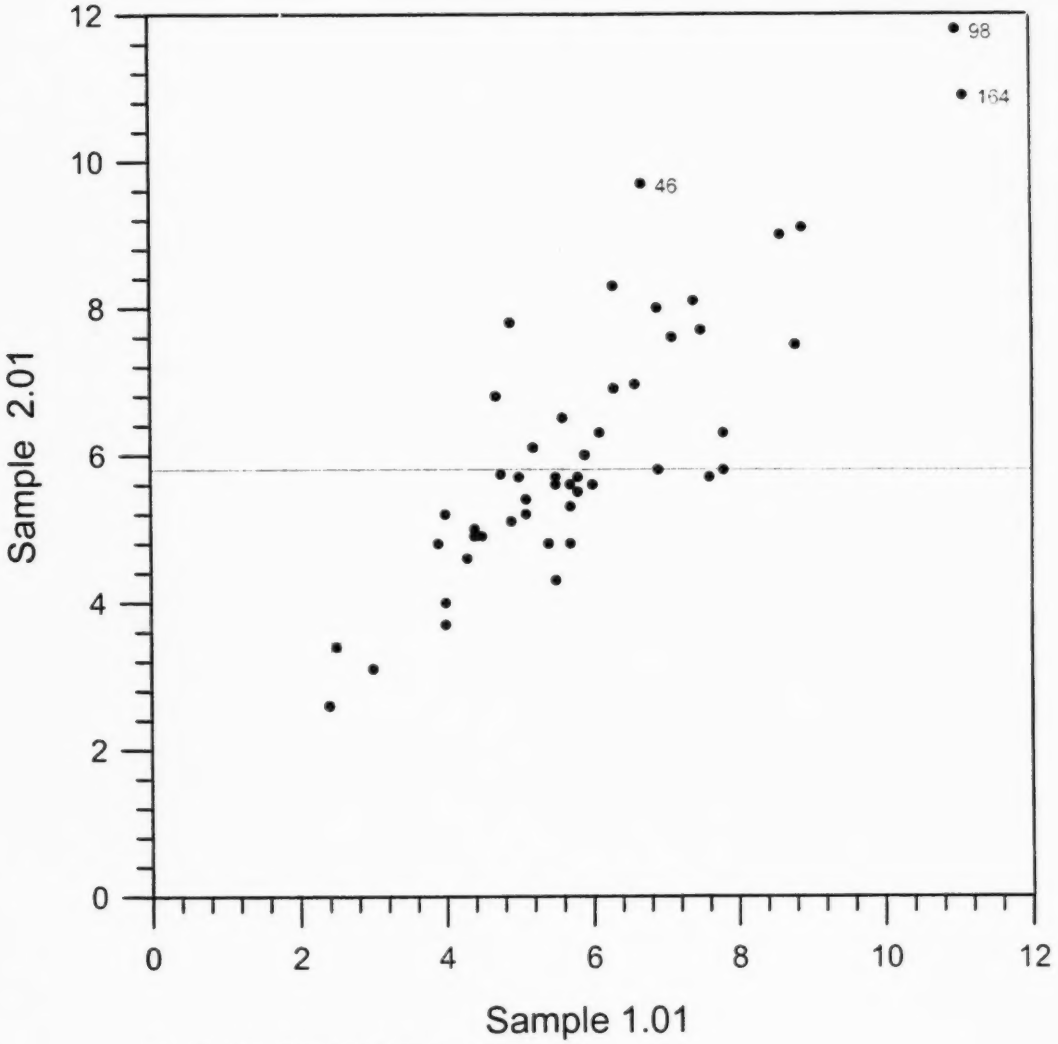


Test 16: Micro-Deval Abrasion Loss (CA), %

	Mat 1	Mat 2
Mean	6.603	6.536
Median	6.600	6.500
Std Dev	0.496	0.476
n = 60		

Labs eliminated by analysis: 23, 46, 123, 187, 306

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

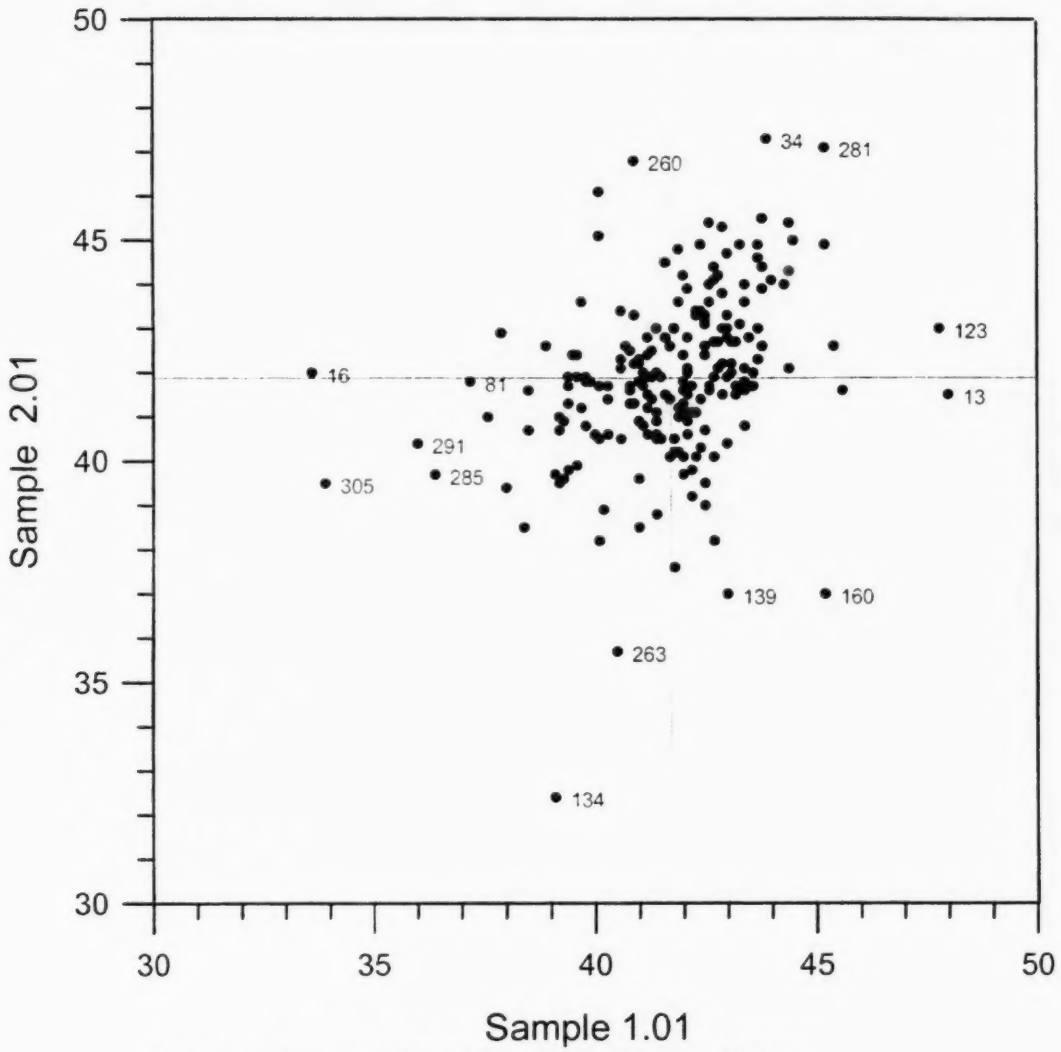


Test 17: Freeze-Thaw Loss, %

	Mat 1	Mat 2
Mean	5.647	5.837
Median	5.700	5.700
Std Dev	1.530	1.473
n = 49		

Labs eliminated: 46, 98, 164

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

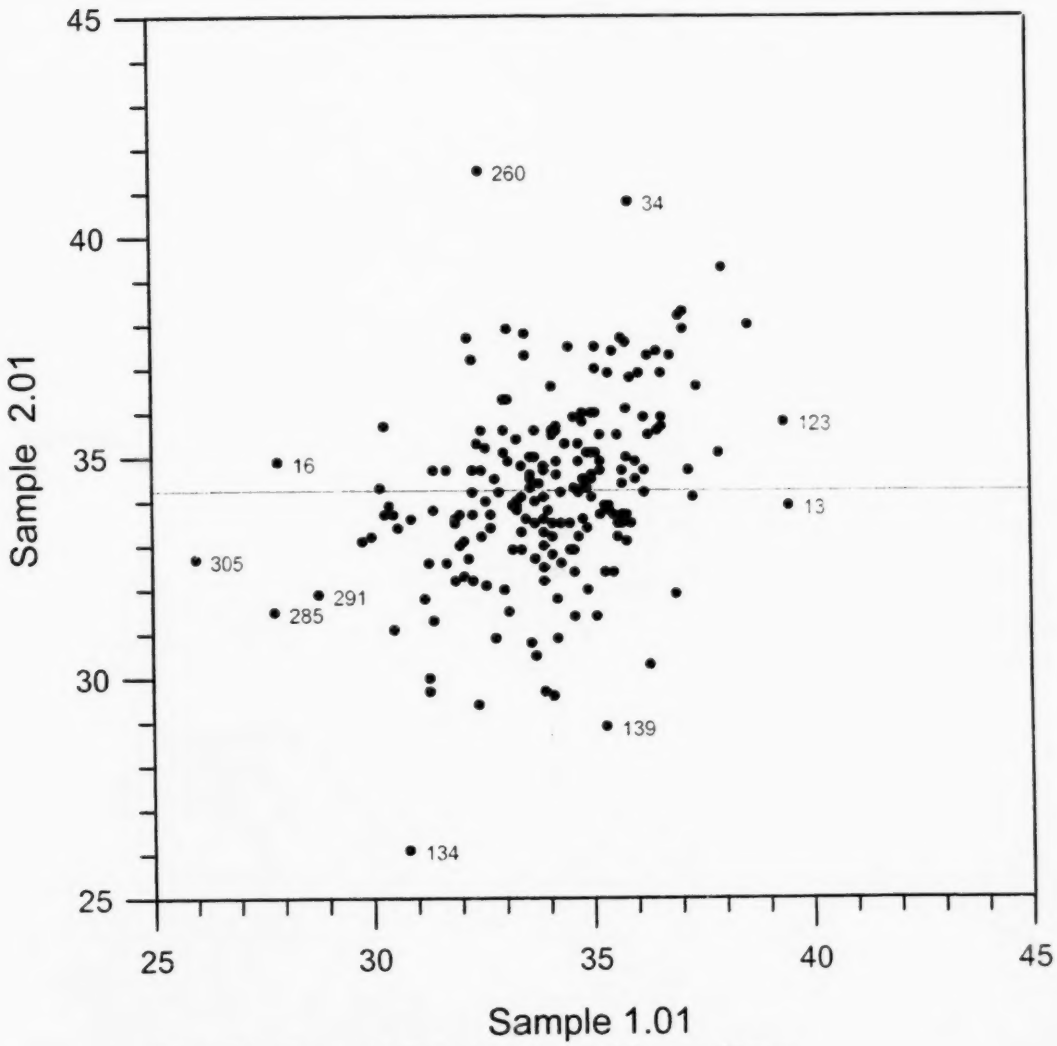


Test 20: Percent Passing the 2.36 mm Sieve

	Mat 1	Mat 2
Mean	41.785	41.964
Median	42.000	41.900
Std Dev	1.521	1.603
n = 194		

Labs Eliminated: 13, 16, 34, 81, 123, 134, 139, 160, 260, 263, 281, 285, 291, 305

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

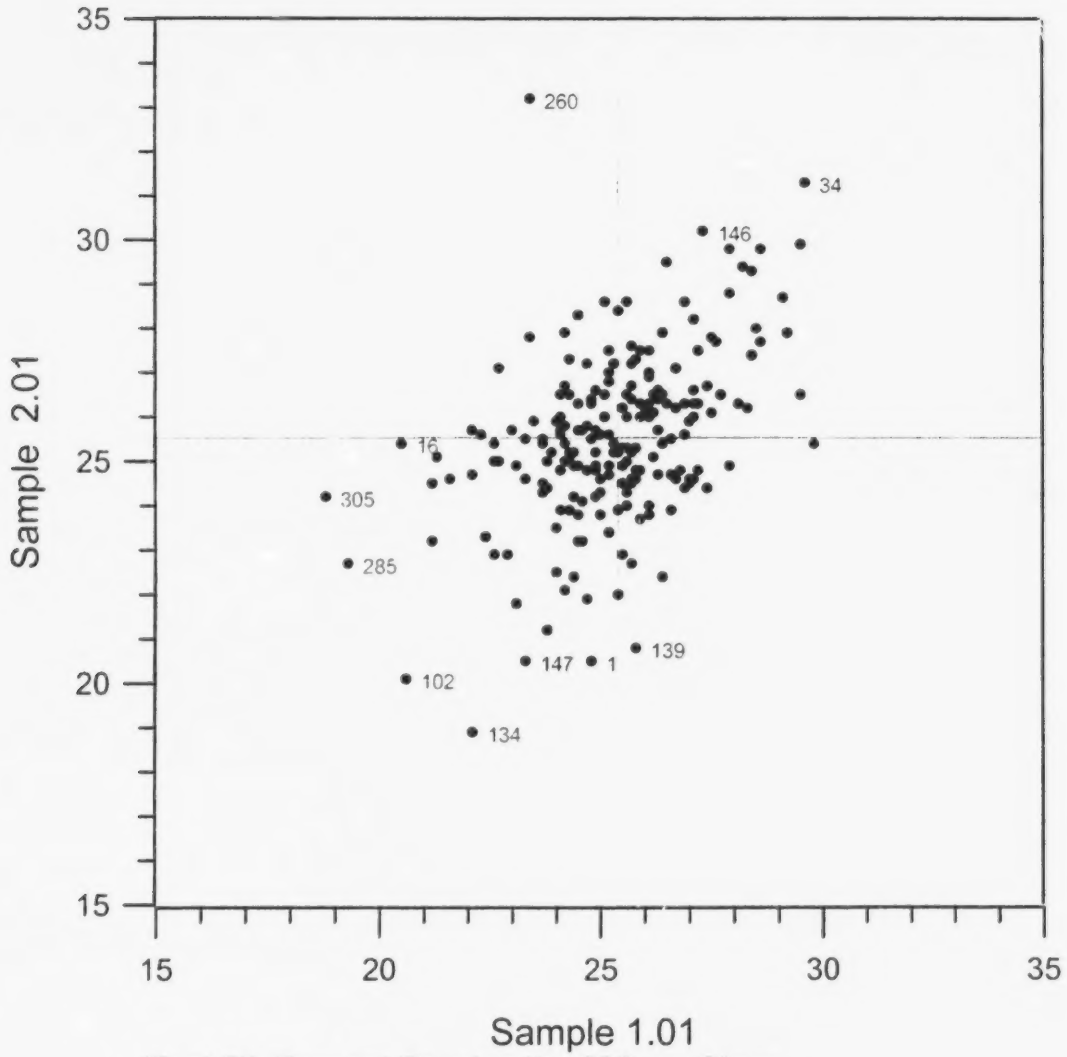


Test 21: Percent Passing the 1.18 mm Sieve

	Mat 1	Mat 2
Mean	34.084	34.283
Median	34.100	34.200
Std Dev	1.736	1.862
n = 198		

Labs Eliminated: 13, 16, 34, 123, 134, 139, 260, 285, 291, 305

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

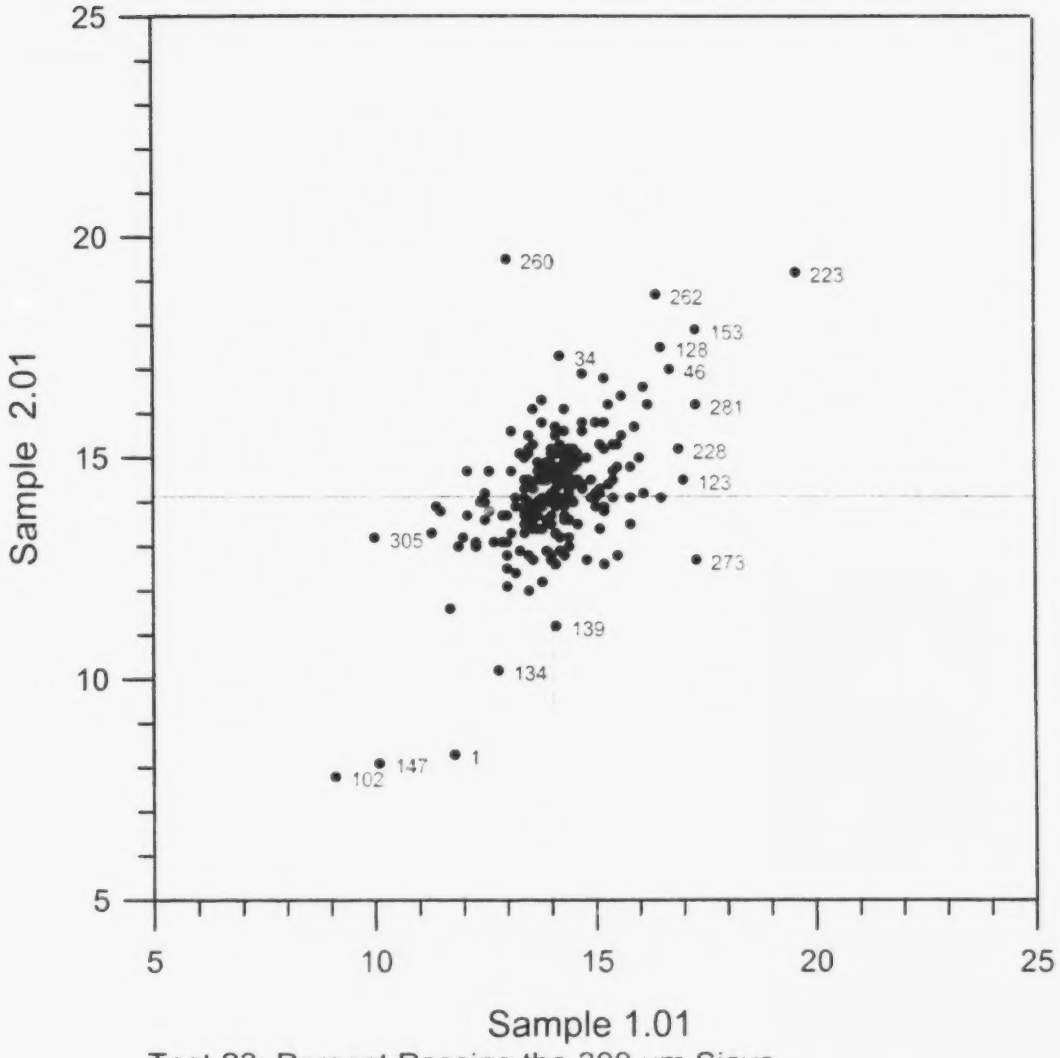


Test 22: Percent Passing the 600 um Sieve

	Mat 1	Mat 2
Mean	25.410	25.628
Median	25.400	25.600
Std Dev	1.639	1.627
n = 197		

Labs Eliminated: 1, 16, 34, 102, 134, 139, 146, 147, 260, 285, 305

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

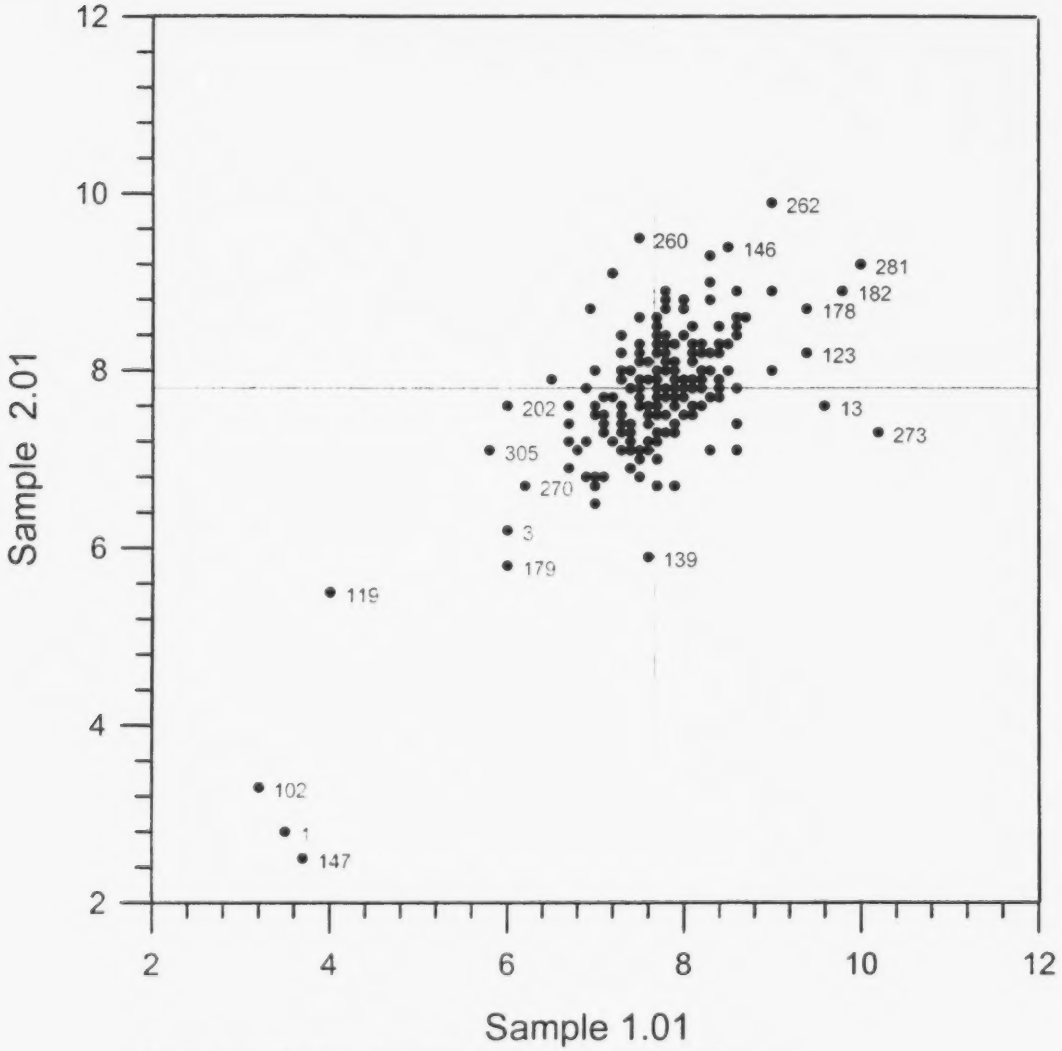


Test 23: Percent Passing the 300 um Sieve

	Mat 1	Mat 2
Mean	14.037	14.218
Median	14.100	14.200
Std Dev	0.958	0.975
n = 191		

Labs Eliminated: 1, 34, 46, 102, 123, 128, 134, 139, 147, 153, 223, 228, 260, 262, 273, 281, 305

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

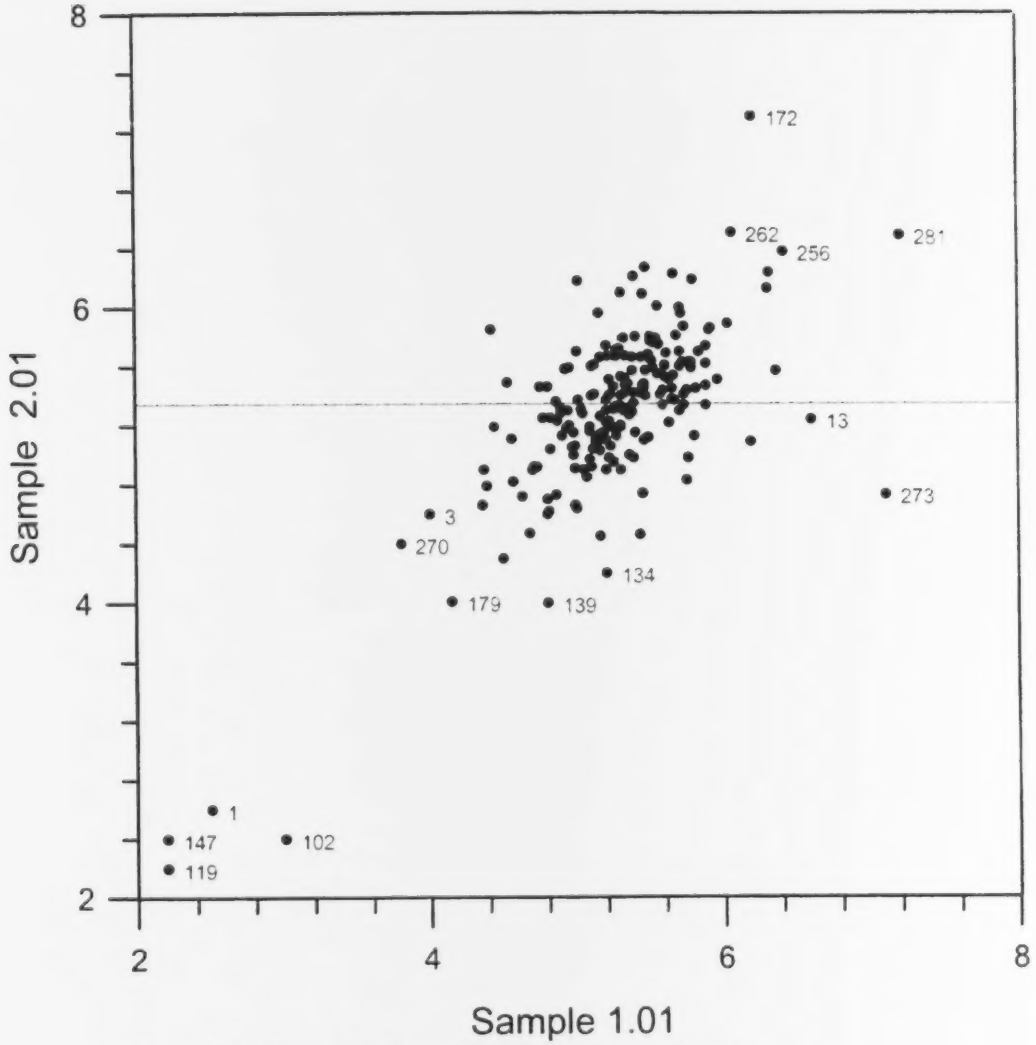


Test 24: Percent Passing the 150 um Sieve

	Mat 1	Mat 2
Mean	7.712	7.811
Median	7.700	7.800
Std Dev	0.483	0.536
n = 189		

Labs Eliminated: 1, 3, 13, 102, 119, 123, 139, 146, 147, 178, 179, 182, 202, 260, 262, 270, 273, 281, 305

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

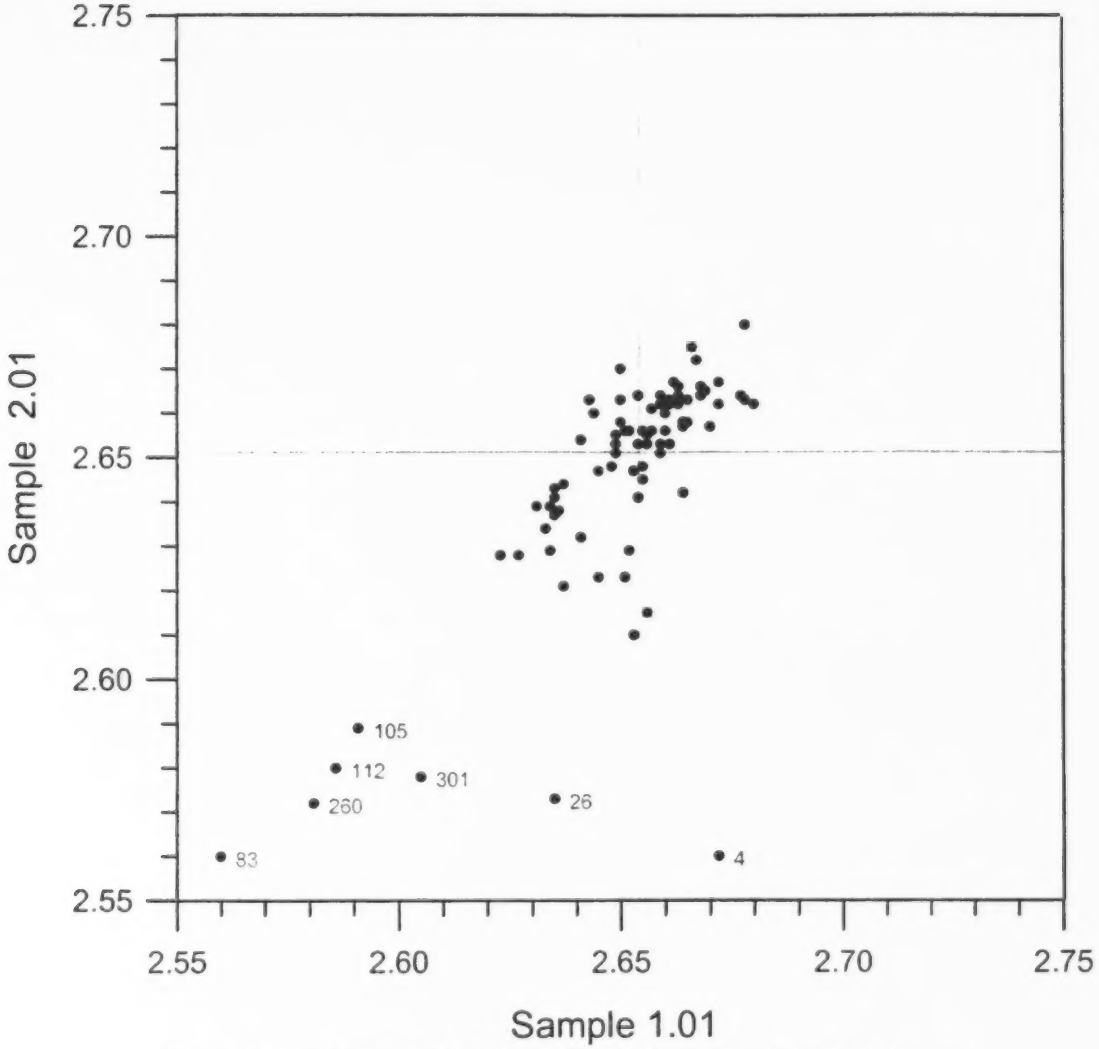


Test 25: Percent Passing the 75 um Sieve

	Mat 1	Mat 2
Mean	5.304	5.372
Median	5.300	5.400
Std Dev	0.381	0.381
n = 193		

Labs Eliminated: 1, 3, 13, 102, 119, 134, 139, 147, 172, 179, 256, 262, 270, 273, 281.

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

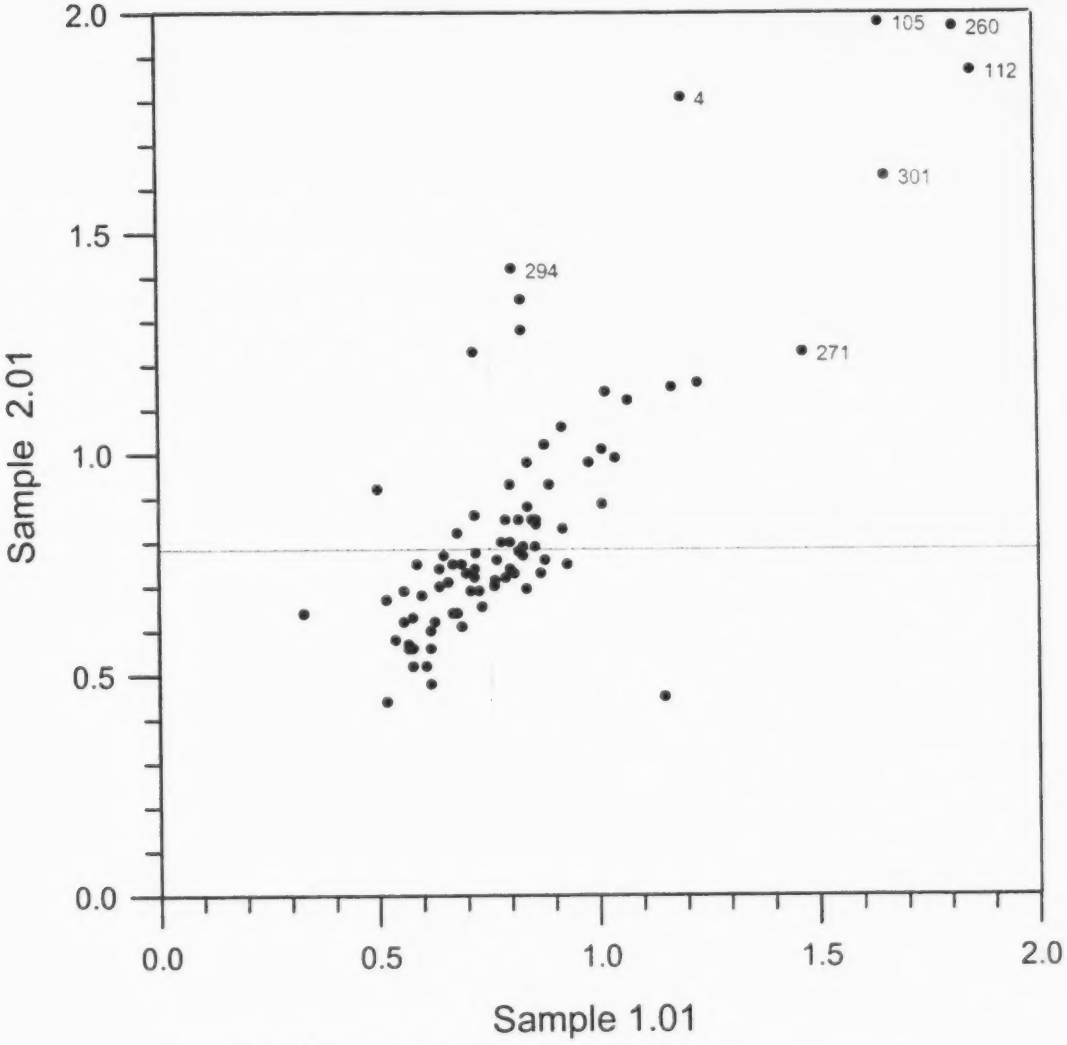


Test 27: Relative Density, (Fine Aggregate - Bulk)

	Mat 1	Mat 2
Mean	2.654	2.652
Median	2.656	2.656
Std Dev	0.013	0.015
n = 78		

Labs Eliminated: 4, 26, 83, 105, 112, 260, 301

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

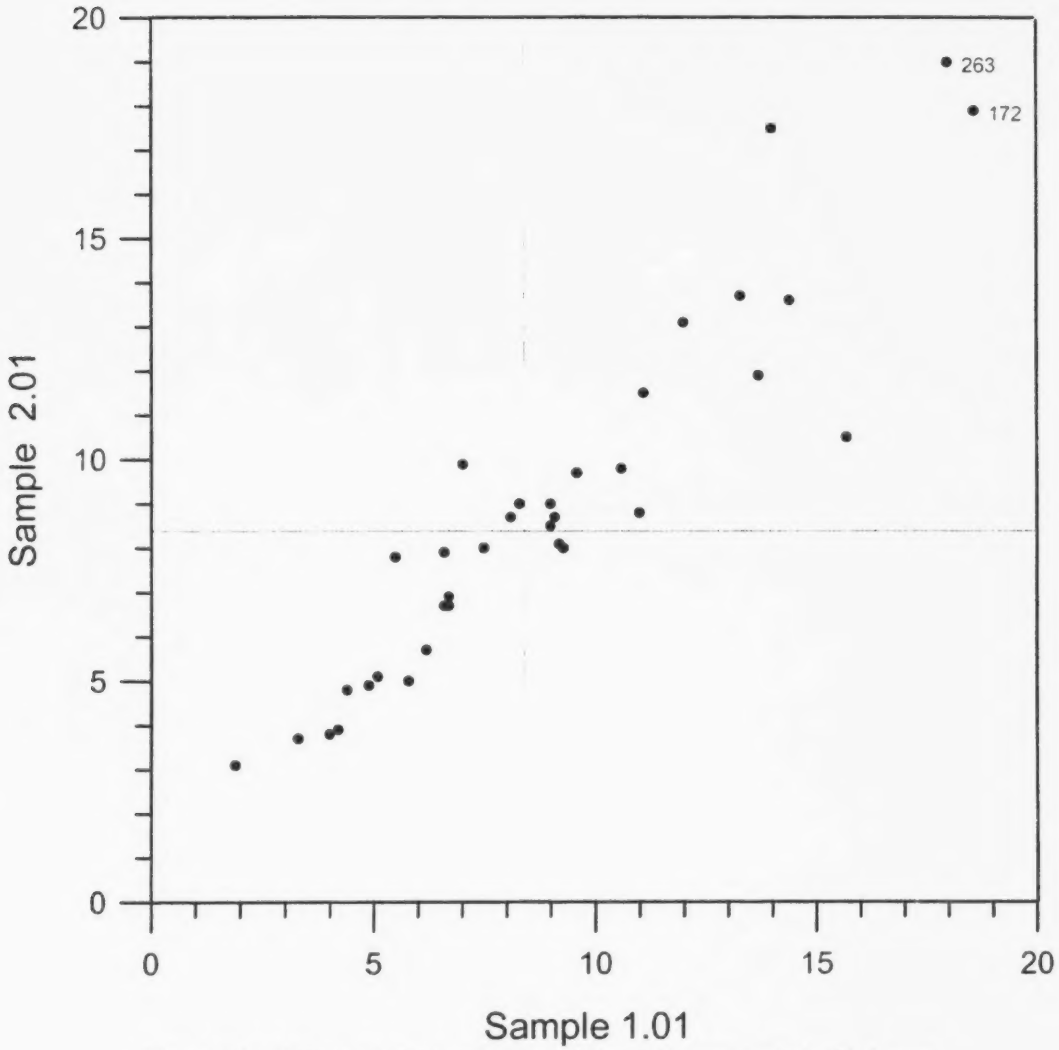


Test 28: Absorption (Fine Aggregate)

	Mat 1	Mat 2
Mean	0.762	0.782
Median	0.765	0.750
Std Dev	0.166	0.188
n = 78		

Labs Eliminated: 4, 105, 112, 260, 271, 294, 301

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

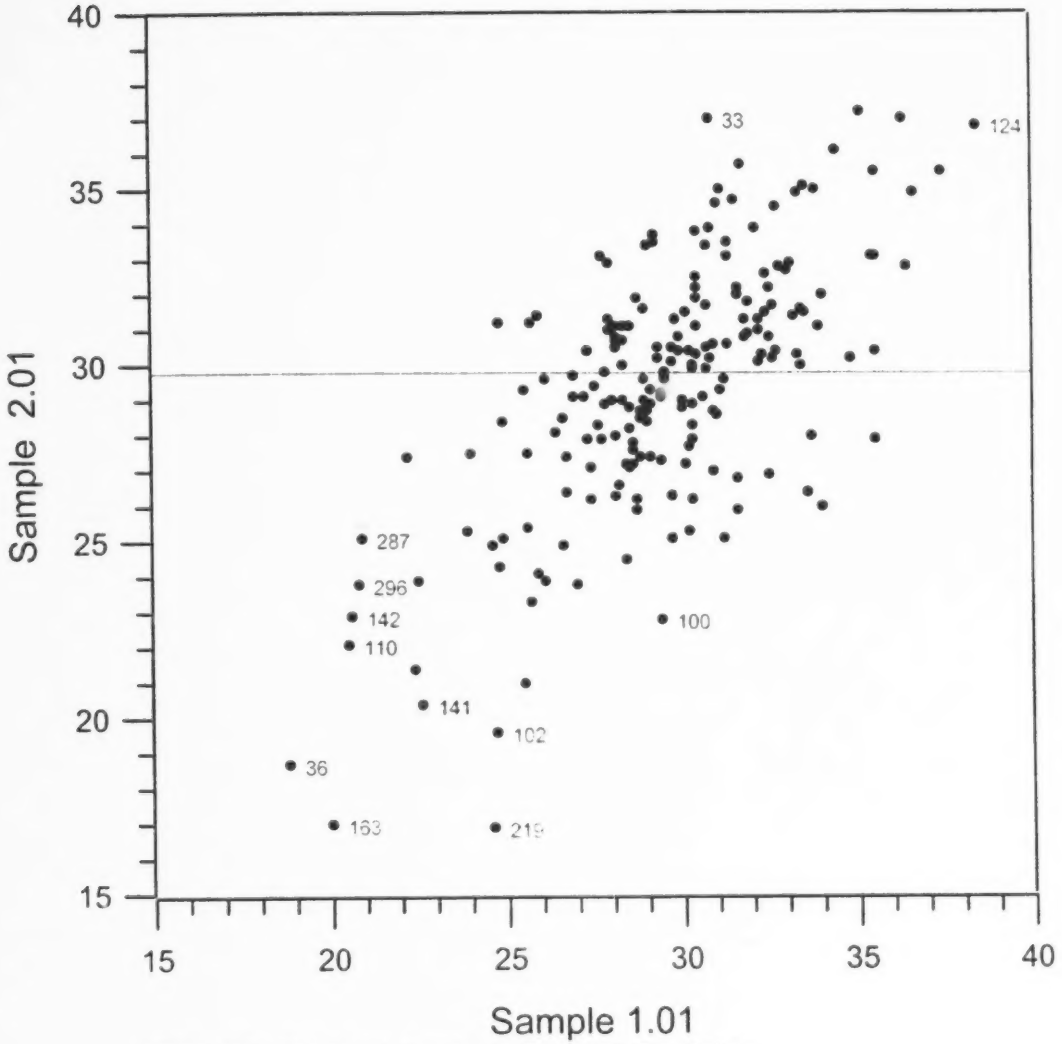


Test 29: MgSO4 Soundness (Fine Aggregate), % Loss

	Mat 1	Mat 2
Mean	8.298	8.303
Median	8.100	8.100
Std Dev	3.481	3.300
n = 33		

Labs Eliminated: 172, 263

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

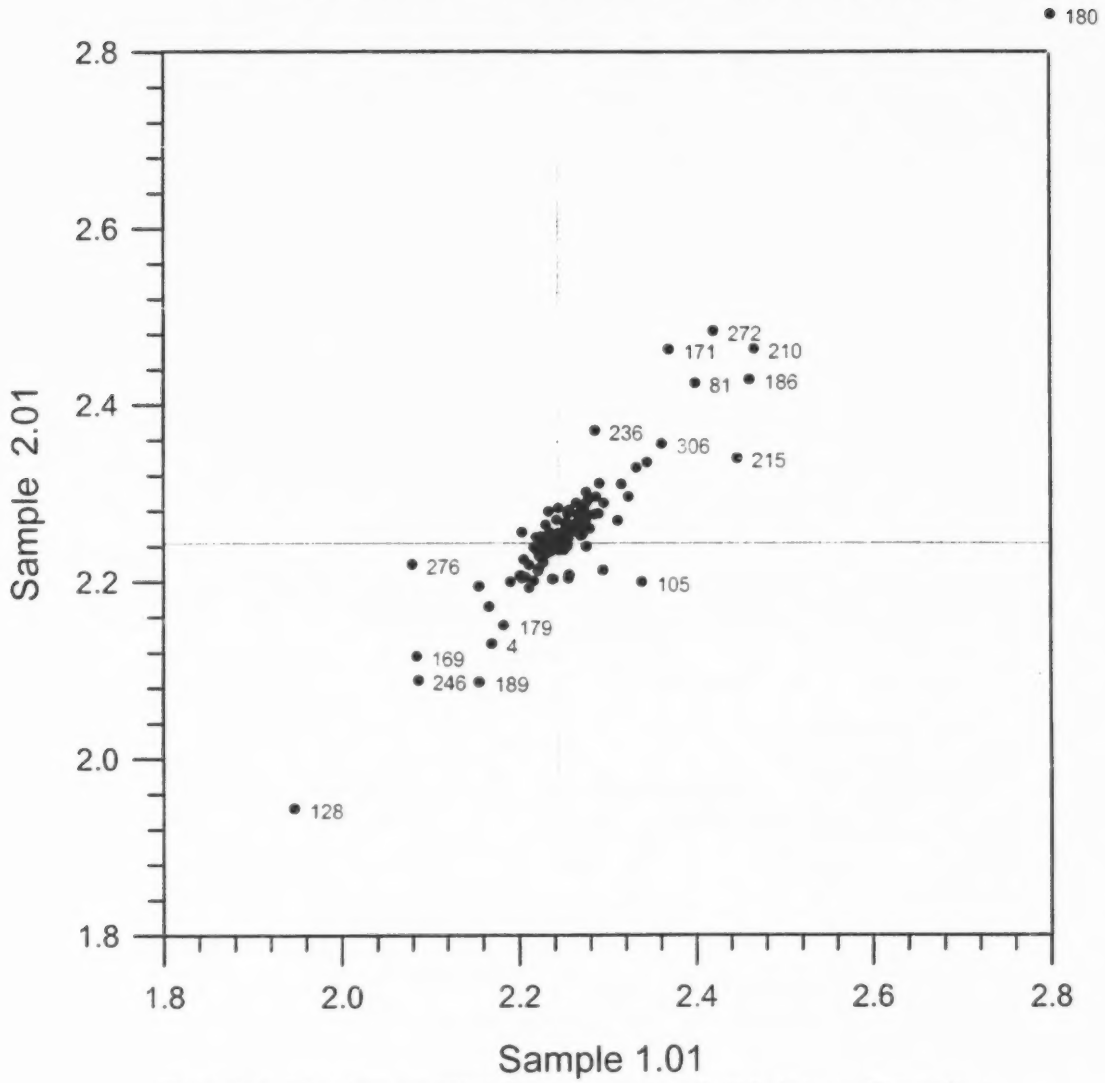


Test 30: Percent Asphalt Coated Particles

	Mat 1	Mat 2
Mean	29.867	29.758
Median	29.850	30.000
Std Dev	2.854	2.954
n = 190		

Labs Eliminated: 33, 36, 100, 102, 110, 124, 141, 142, 163, 219, 287, 296,

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

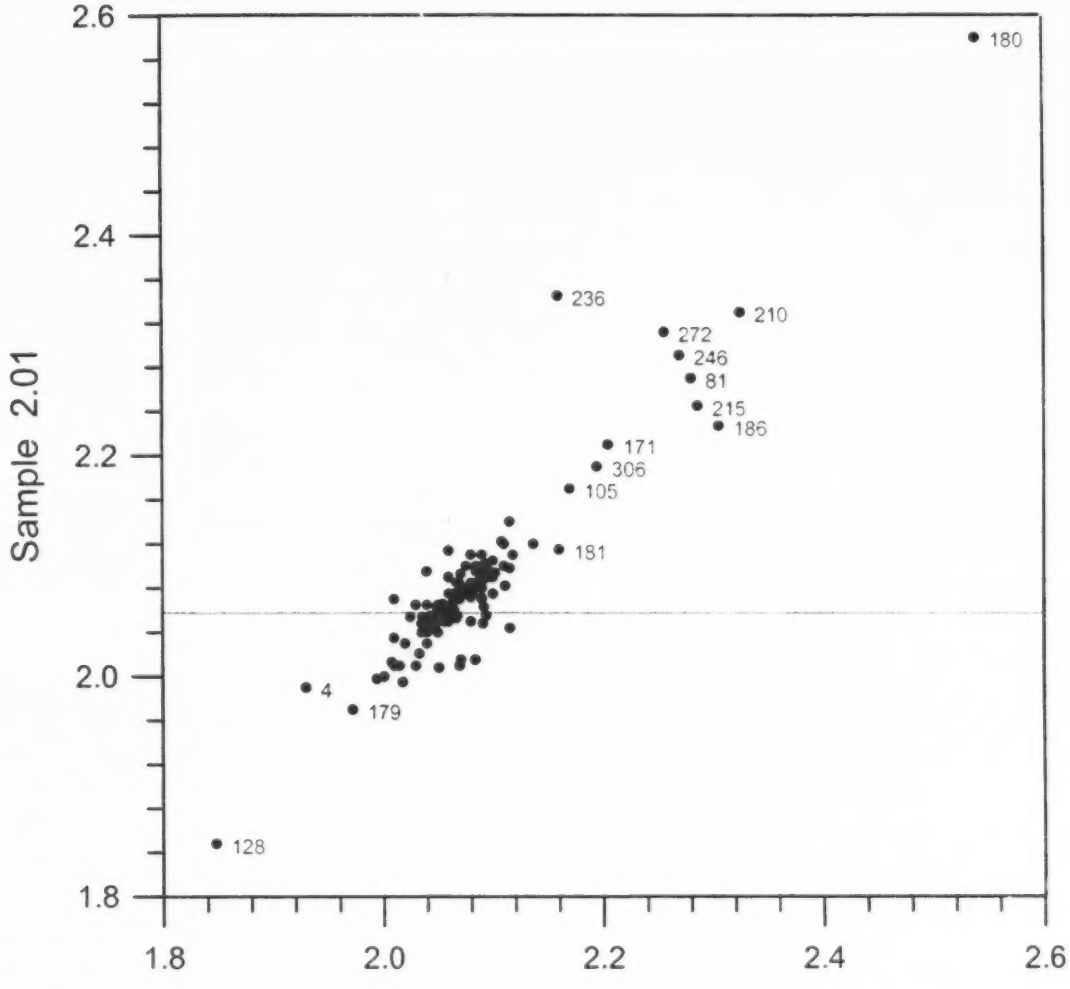


Test 31: Maximum Wet Density g/cm3 (Moisture-Density)

	Mat 1	Mat 2
Mean	2.248	2.249
Median	2.246	2.249
Std Dev	0.028	0.026
n = 127		

Labs Eliminated: 4, 81, 105, 128, 169, 171, 179, 180, 186, 189, 210, 215, 236, 246, 272, 276, 306

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

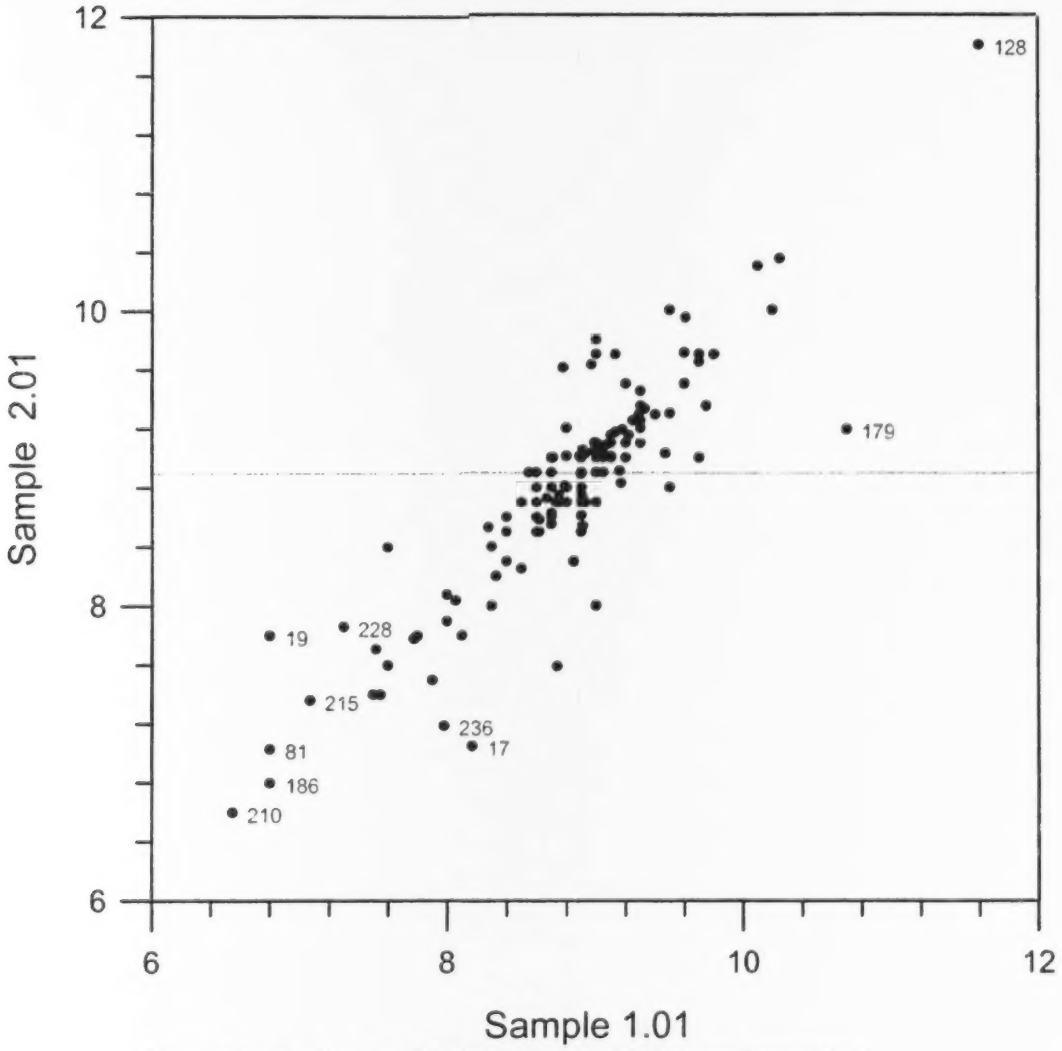


Test 32: Maximum Dry Density g/cm3 (Moisture-Density)

	Mat 1	Mat 2
Mean	2.066	2.066
Median	2.067	2.065
Std Dev	0.028	0.029
n = 129		

Labs Eliminated: 4, 81, 105, 128, 171, 179, 180, 181, 186, 210, 215, 236, 246, 272, 306

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

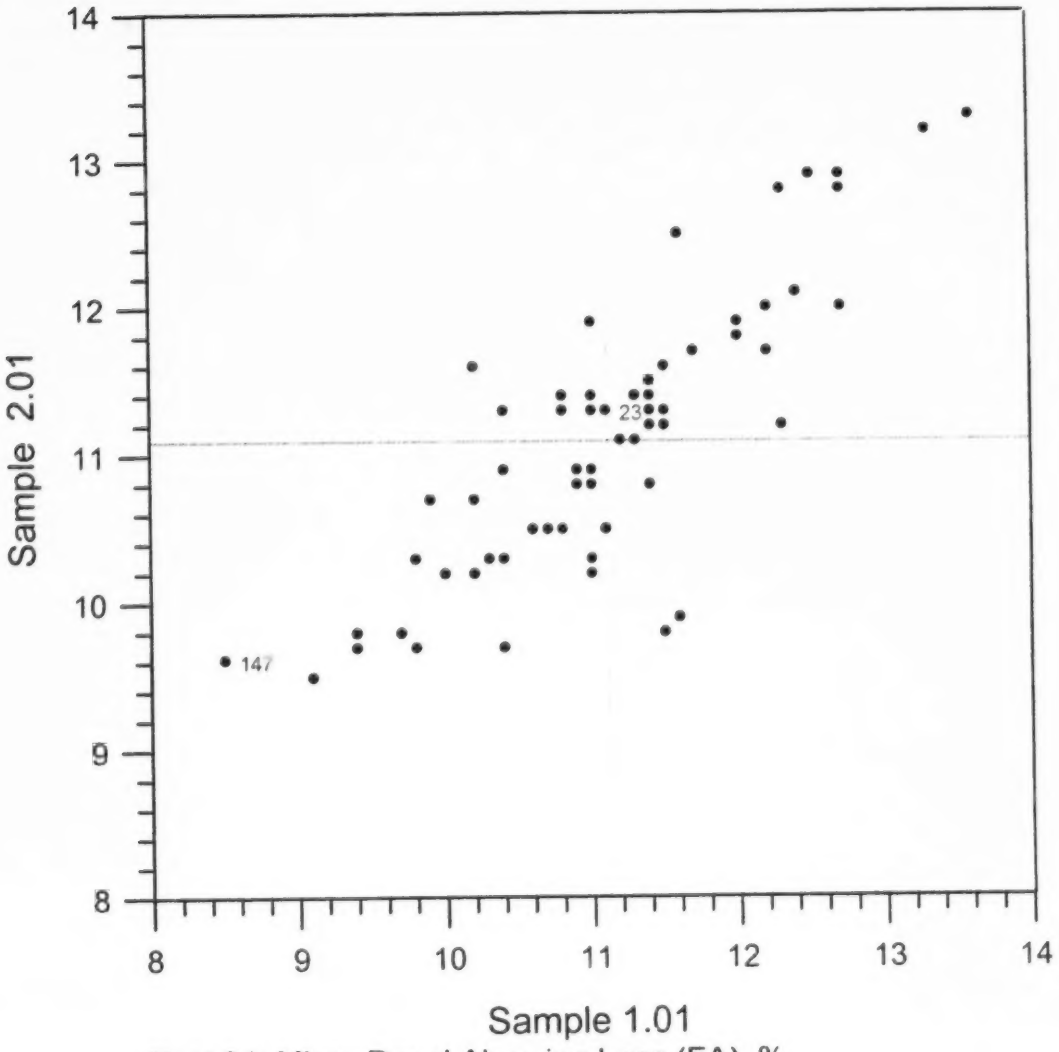


Test 33: Optimum Moisture, % (Moisture Density)

	Mat 1	Mat 2
Mean	8.889	8.877
Median	8.910	8.910
Std Dev	0.507	0.555
n = 133		

Labs Eliminated. 17, 19, 81, 128, 179, 186, 210, 215, 228, 236,

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

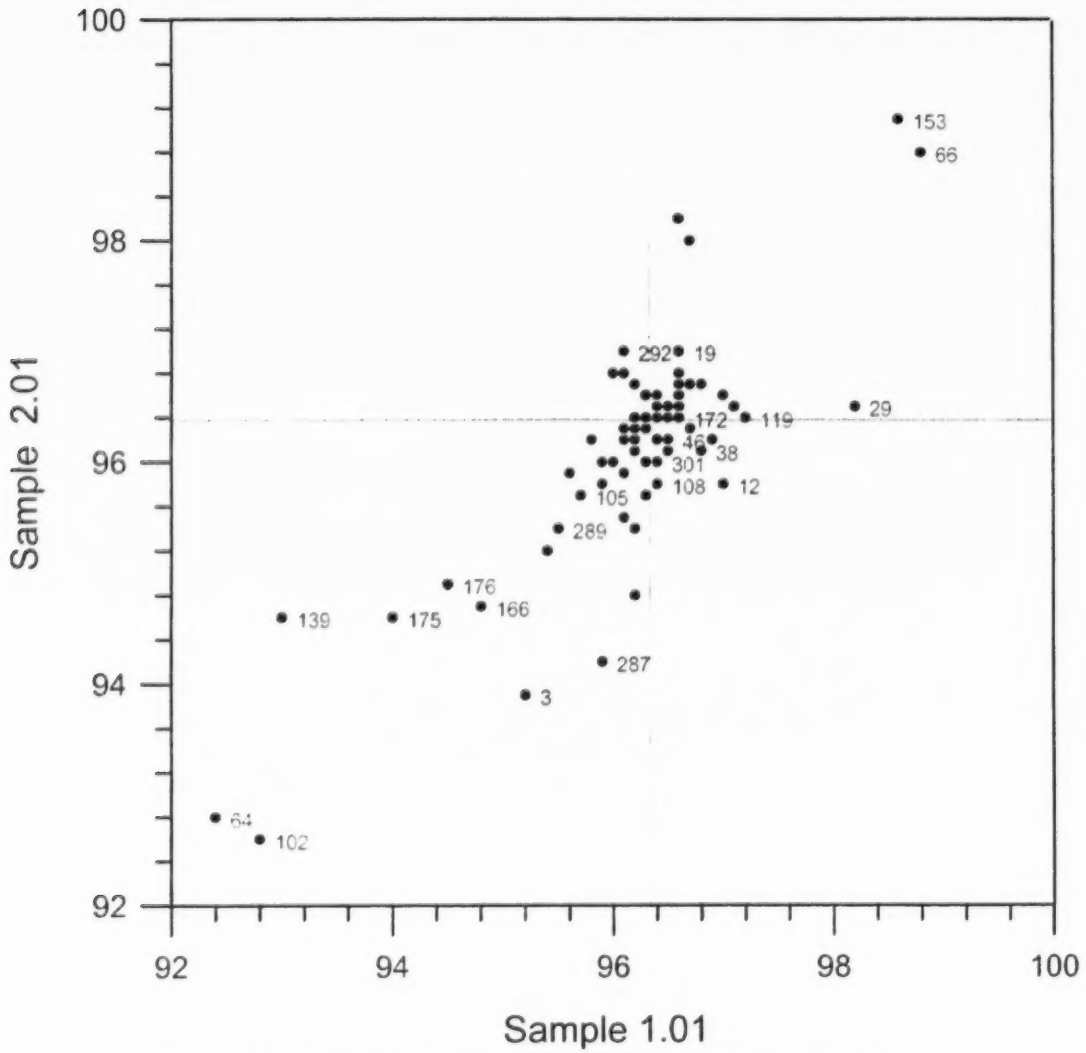


Test 34: Micro-Deval Abrasion Loss (FA), %

	Mat 1	Mat 2
Mean	11.148	11.127
Median	11.000	11.200
Std Dev	0.964	0.938
n = 62		

Labs eliminated: 23, 147

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

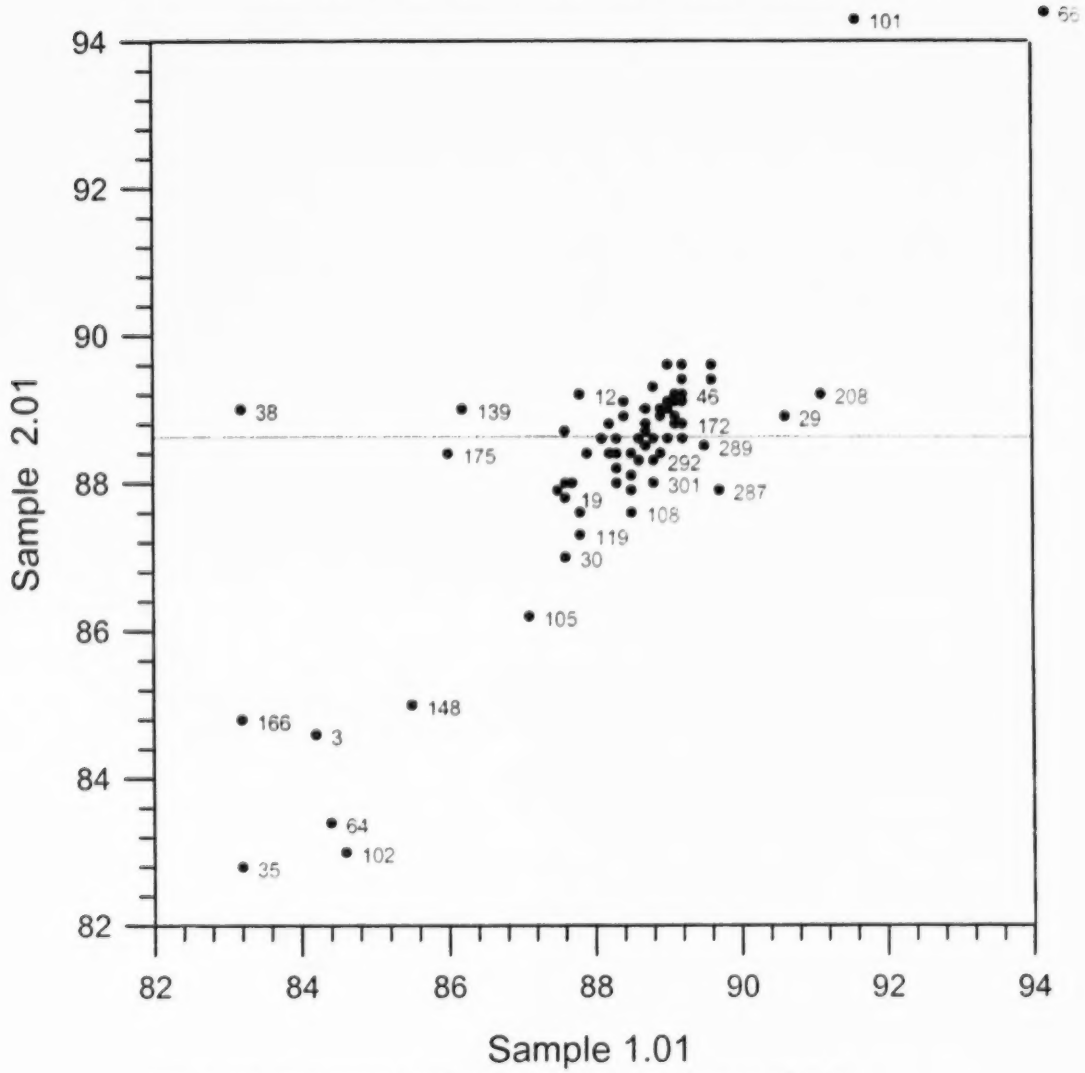


Test 41: Percent Passing the 425 µm Sieve (Soil)

	Mat 1	Mat 2
Mean	96.338	96.338
Median	96.300	96.300
Std Dev	0.332	0.553
n = 65		

Labs eliminated: 3, 12, 19, 29, 38, 46, 64, 66, 102, 105, 108, 119, 139, 153, 166, 172, 175, 176, 287, 289, 292, 301

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

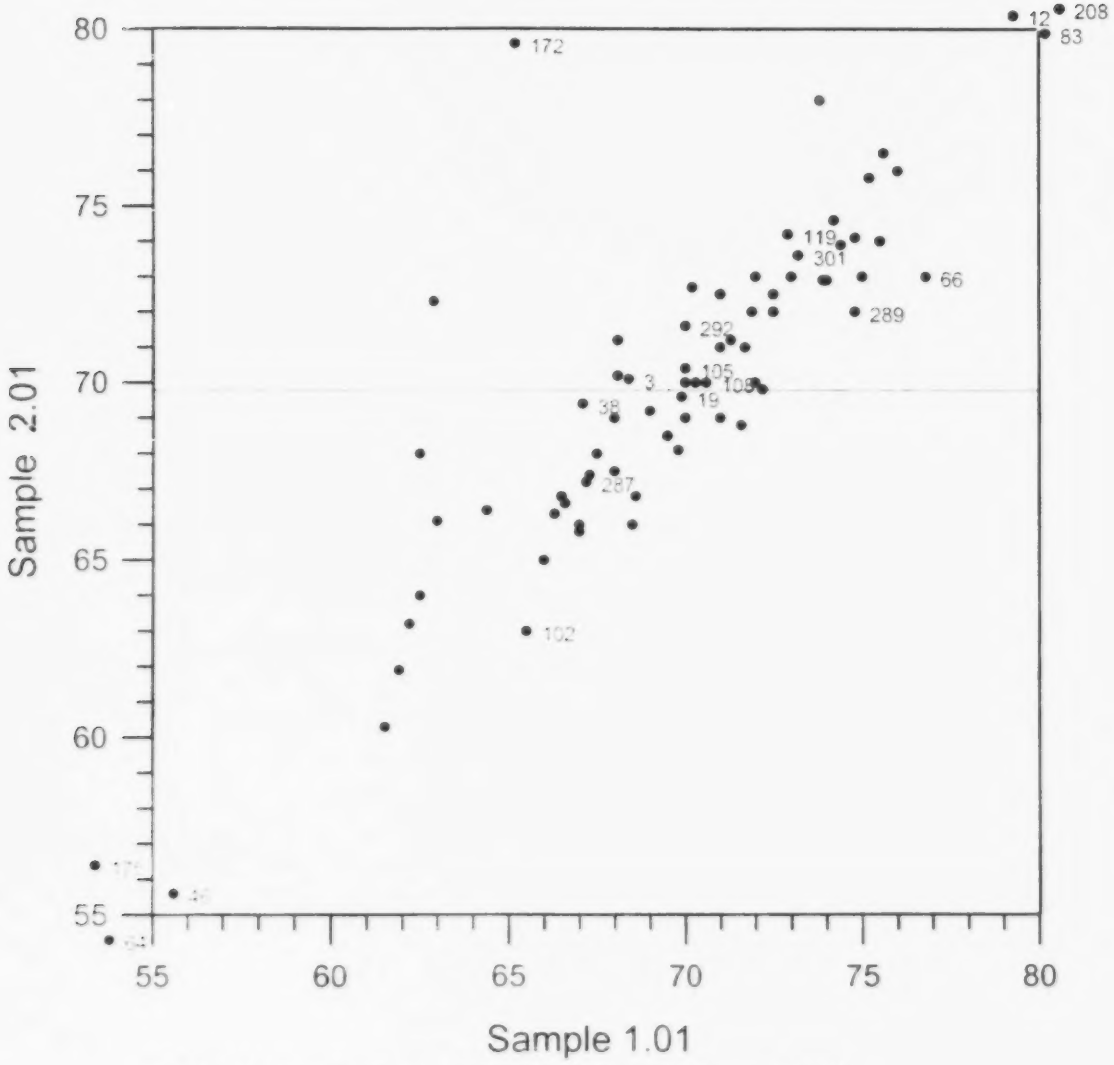


Test 42: Percent Passing the 75 μm Sieve (Soil)

	Mat 1	Mat 2
Mean	88.647	88.713
Median	88.700	88.600
Std Dev	0.512	0.479
n = 62		

Labs eliminated: 3, 12, 19, 29, 30, 35, 38, 46, 64, 66, 101, 102, 105, 108, 119, 139, 148, 166, 172 175, 208, 287, 289, 292, 301

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

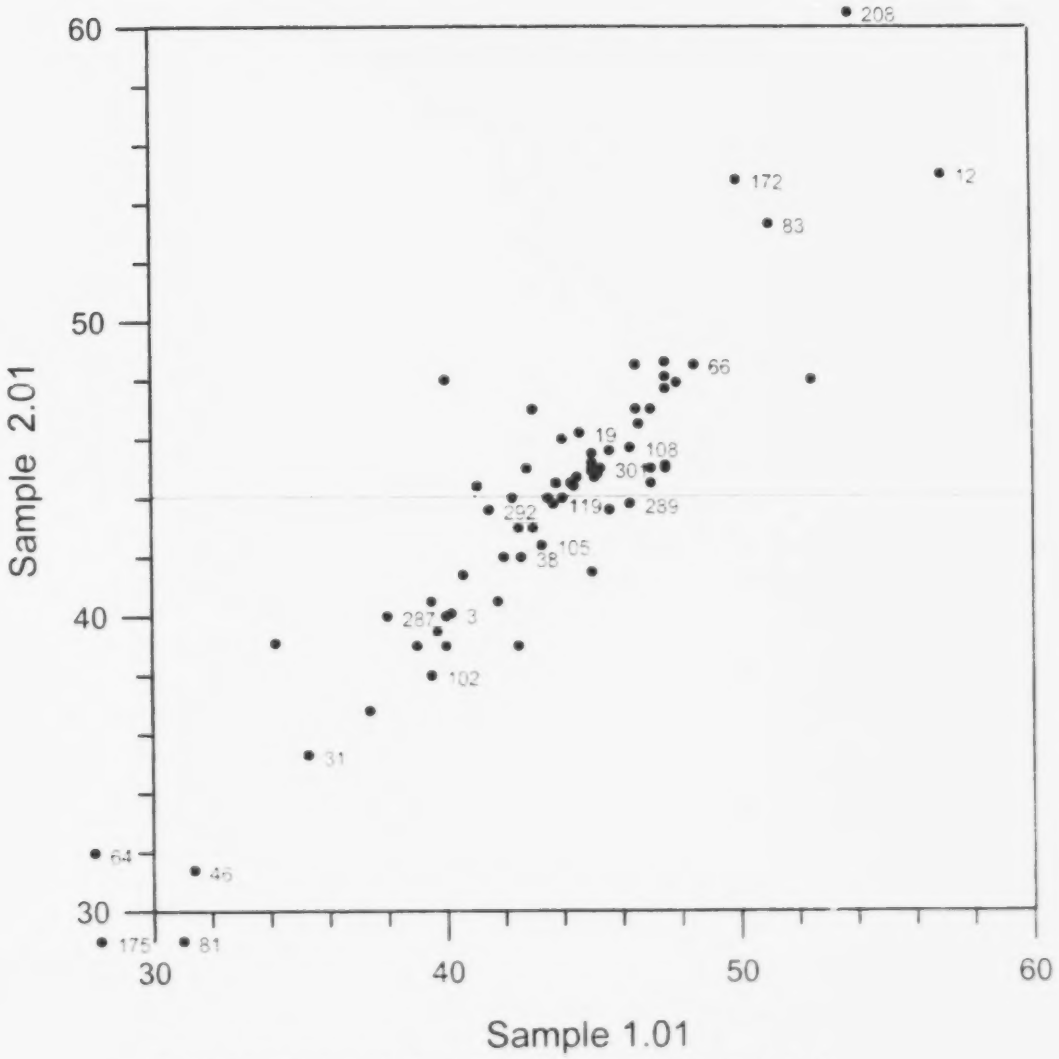


Test 43: Percent Passing the 20 µm Sieve (Soil)

	Mat 1	Mat 2
Mean	69.609	69.808
Median	70.000	70.000
Std Dev	4.027	3.791
n = 68		

Labs eliminated: 3, 12, 19, 38, 46, 64, 66, 83, 102, 105, 108, 119, 172, 175, 208, 287, 289, 292, 301

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

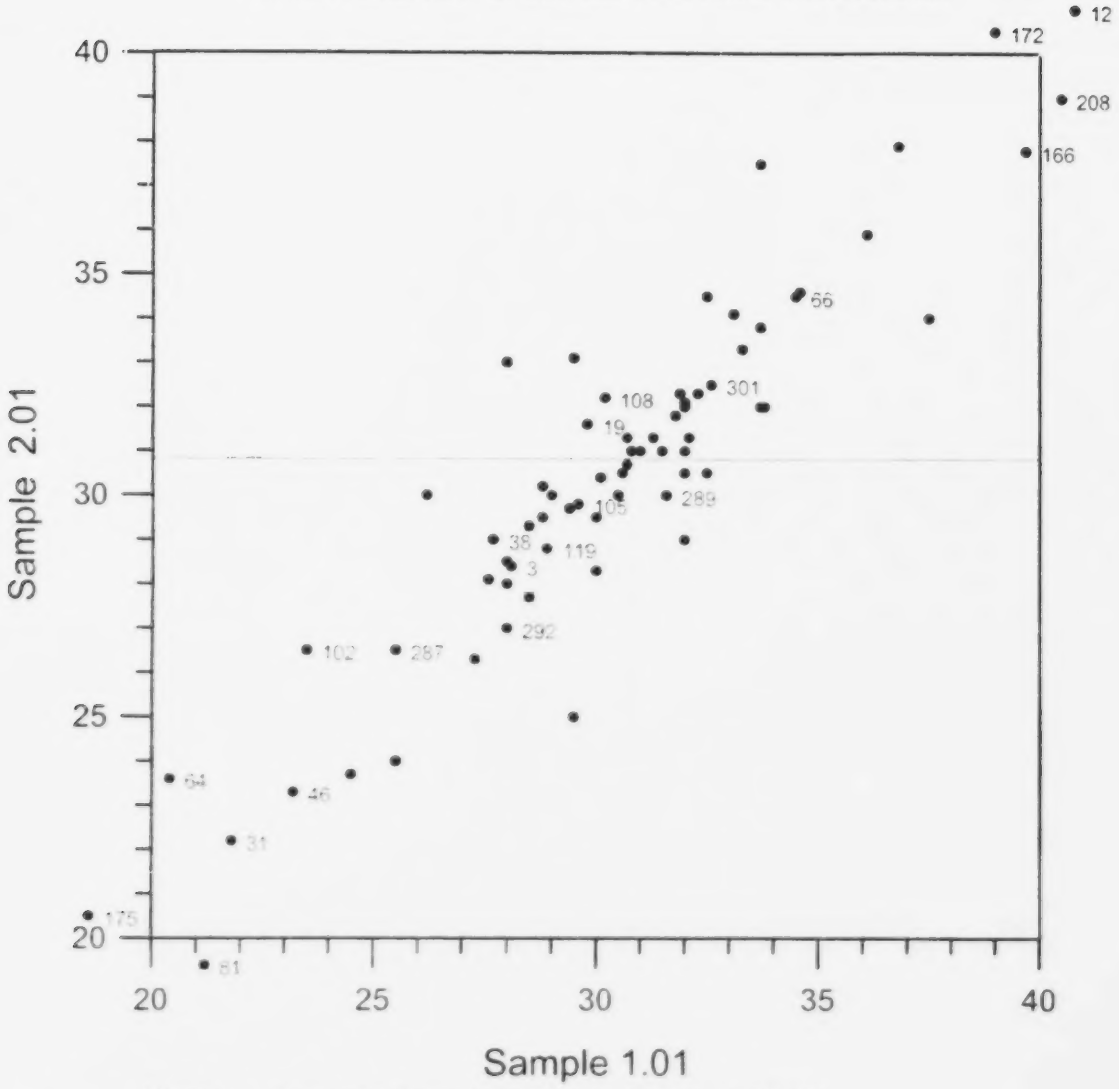


Test 44: Percent Passing the 5 μm Sieve (Soil)

	Mat 1	Mat 2
Mean	43.863	44.020
Median	44.350	44.600
Std Dev	3.227	2.912
n = 66		

Labs eliminated: 3, 12, 19, 31, 38, 46, 64, 66, 81, 83, 102, 105, 108, 119, 172, 175, 208, 287, 289, 292, 301

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

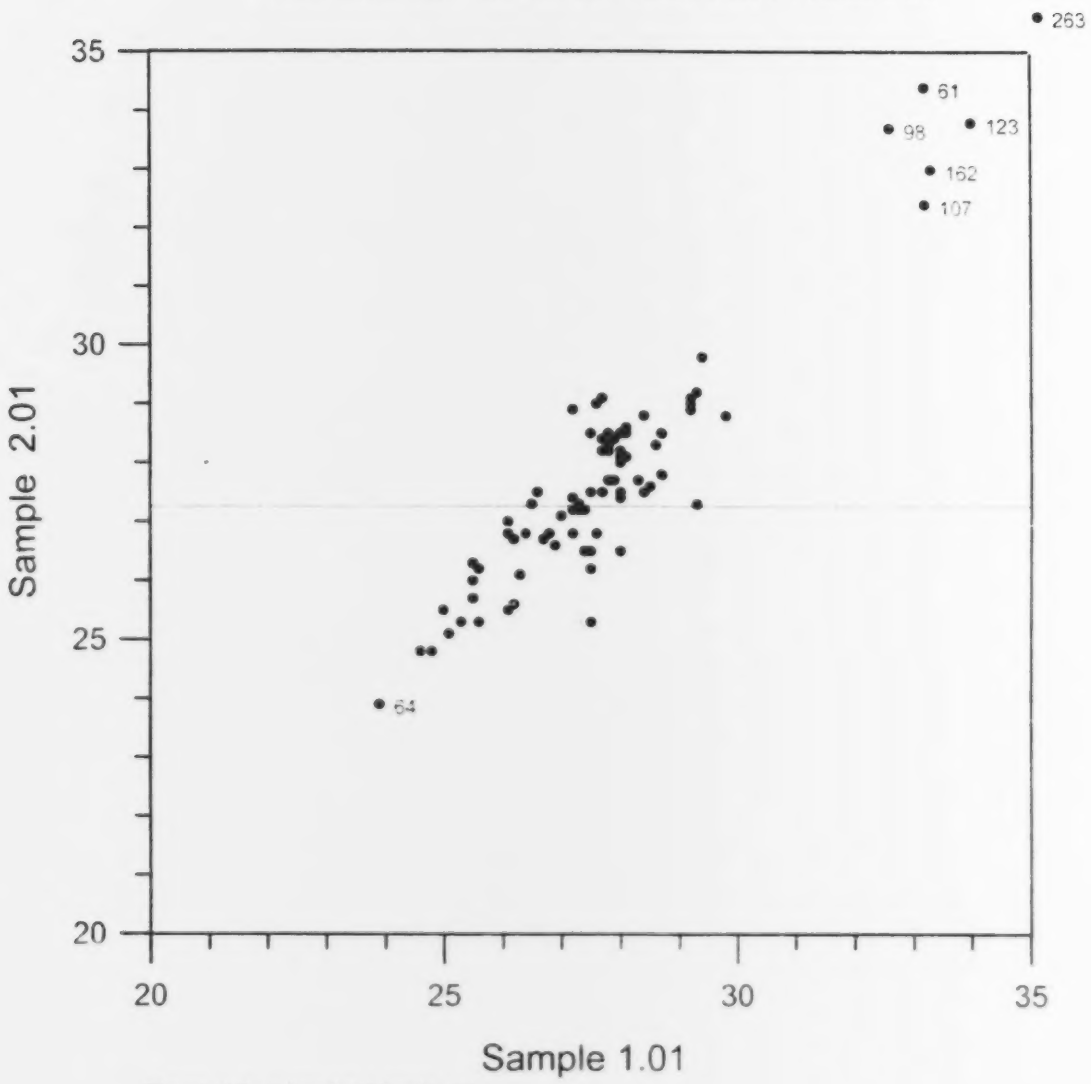


Test 45: Percent Passing the 2 µm Sieve (Soil)

	Mat 1	Mat 2
Mean	30.882	30.880
Median	30.750	30.600
Std Dev	2.692	2.889
n = 66		

Labs eliminated: 3, 12, 19, 31, 38, 46, 64, 66, 81, 102, 105, 108, 119, 166, 172, 175, 208, 287, 289, 292, 301

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

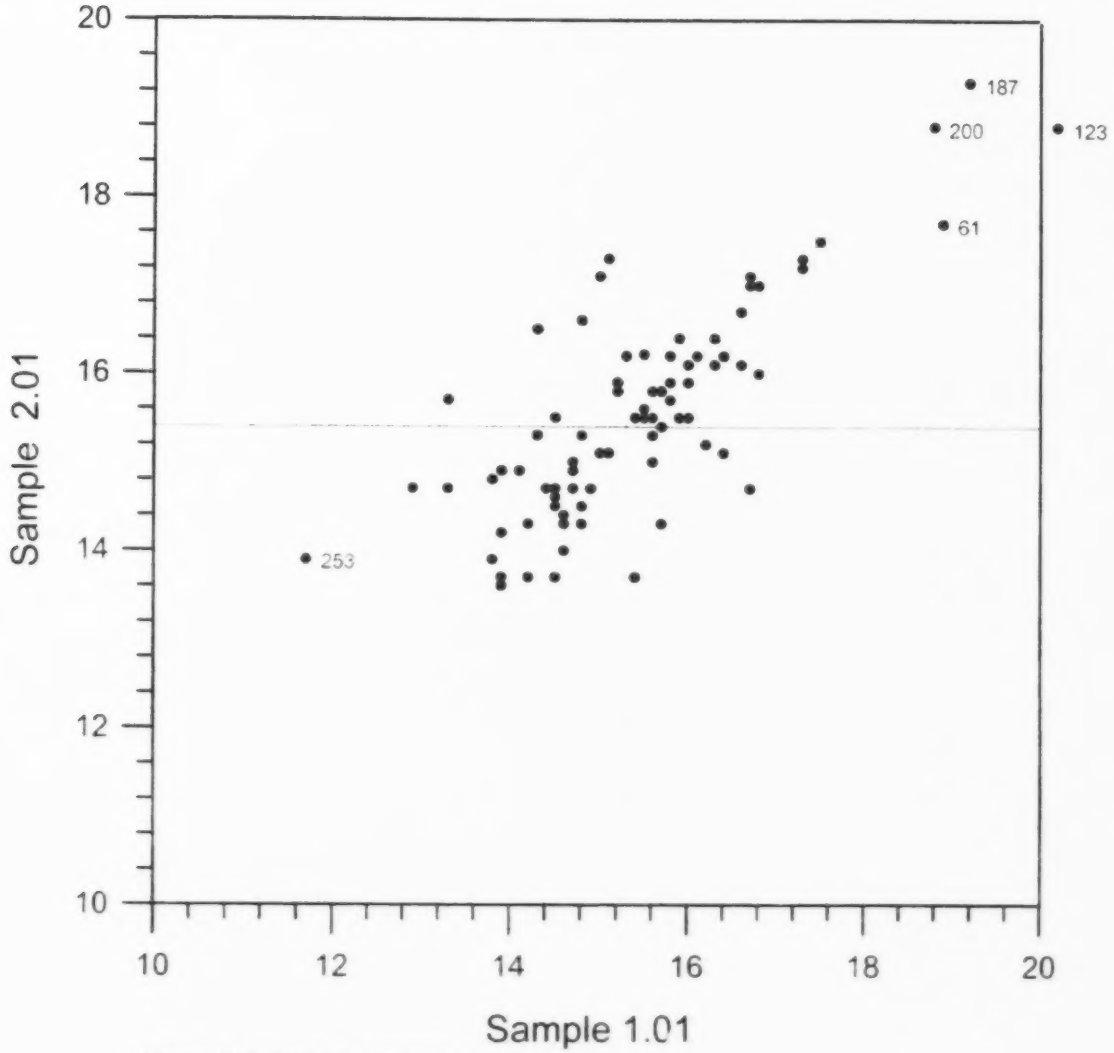


Test 46: Liquid Limit, %

	Mat 1	Mat 2
Mean	27.354	27.343
Median	27.500	27.400
Std Dev	1.182	1.187
n = 74		

Labs eliminated: 61, 64, 98, 107, 123, 162, 263

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

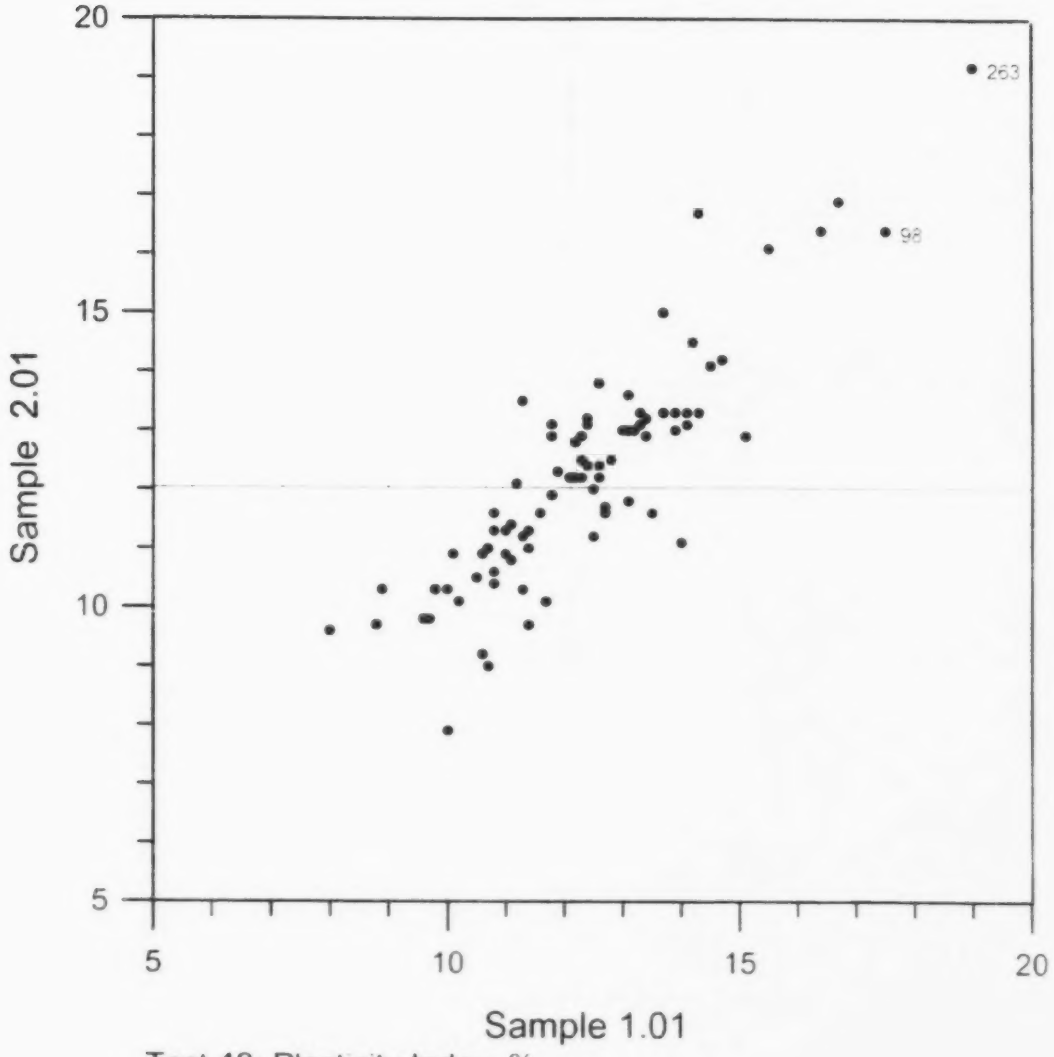


Test 47: Plastic Limit, %

	Mat 1	Mat 2
Mean	15.271	15.413
Median	15.350	15.500
Std Dev	1.011	0.983
n = 76		

Labs eliminated: 61, 123, 187, 200, 253

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

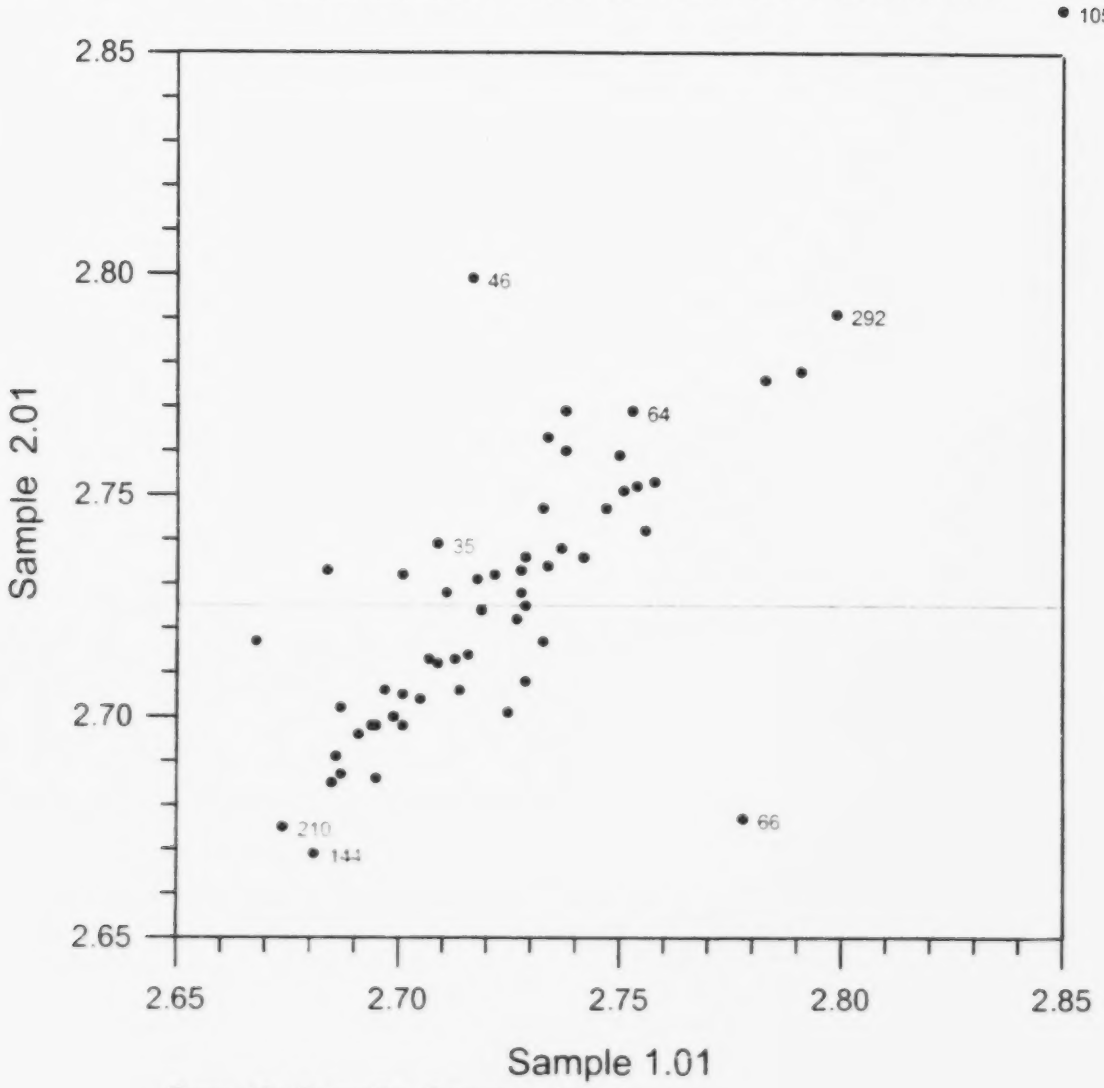


Test 48: Plasticity Index, %

	Mat 1	Mat 2
Mean	12.185	12.091
Median	12.300	12.200
Std Dev	1.695	1.740
n = 79		

Labs eliminated: 98, 263

2001 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



Test 49: Specific Gravity of Soil

	Mat 1	Mat 2
Mean	2.720	2.725
Median	2.719	2.725
Std Dev	0.026	0.025
n = 55		

Labs eliminated: 35, 46, 64, 66, 105, 144, 210, 292

Results of Petrographic Correlation

Results of Coarse Aggregate Petrographic Correlation Study
2001 Interlaboratory Testing Program
Stockpile Samples (Full Fraction)

Laboratory Number	**13**	**13**	**15**	**15**	**19**	**19**	**22**	**22**	**28**	**28**	**31**	**31**
Sample Number	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Carbonate (hard; silty, hard)	89.7	86	79.5	79.4	0.2	0	65.6	70.1	53.2	60.5	79.4	75.8
Carbonate ((silty,) surf. weath.; (silty,) med. hard)	8.5	9.9	0.9	11.3	0.5	1.6	10.8	14.4	34.5	30.8	12.5	20.7
Carbonate (sandy, hard or medium hard)	0.1	0.3	0	0	3.9	0	3.1	1.8	0	0	0	0
Carbonate (slightly cherty: <5% chert)	0	0	8.6	2.4	2.9	0.3	0	0	1.8	2.1	0	0
Marble (hard or medium hard)	0	0	0	0.5	0	0	0	0	0	0	0	0
Conglomerate-Sandstone-Arkose (hard)	0	0	0	0	70.7	86.3	0	0	0	0	0.2	0
Conglomerate-Sandstone-Arkose (medium hard)	0	0	0	0	1.4	1.5	0	0	0	0	0	0
Greywacke-Argillite (hard or medium hard)	0	0	0	0	14.7	3.8	0	0	0	0	0	0
Gneiss-Amphibolite-Schist (hard)	0	0	0	0	0	1	0	0	0	0	0	0
Granite-Diorite-Gabbro (hard)	0	0	0	0	0	0	0	0	0	0	0	0
Total Good Aggregate (%)	**98.3**	**96.2**	**89**	**93.6**	**94.3**	**94.5**	**79.5**	**86.3**	**89.5**	**93.4**	**92.1**	**96.5**
Carbonate (soft; silty, soft; slightly shaley)	1.4	3.1	7.7	1.9	0	0	14.7	11.1	2.9	3.2	6.8	3.3
Carbonate (soft, pitted)	0	0	0	0	0.8	0	0	0	5.6	2.3	0	0
Carbonate (deeply weath.; silty, deeply weath.)	0.1	0	0	0	0	0	0	0	0	0	0	0
Carbonate (sandy, soft)	0	0	0	0	0.9	0	0	0	0	0	0	0
Chert-Cherty Carbonate (<20% leached chert)	0	0	0	0	0	0	0.5	0	2	1.1	0	0
Conglomerate-Sandstone-Arkose (brittle)	0	0	0	0	0.2	1.6	0	0	0	0	0	0
Greywacke (brittle)	0	0	0	0	0	0.8	0	0	0	0	0	0
Encrustation	0	0	0	0	0	0	0.5	0	0	0	0	0
Gneiss-Amphibolite-Schist (brittle)	0	0	0	0	0.6	2.6	0	0	0	0	0	0
Argillite (medium soft)	0	0	0	0	3.2	0.5	0	0	0	0	0	0
Total Fair Aggregate (%)	**1.5**	**3.1**	**7.7**	**1.9**	**5.7**	**5.5**	**15.7**	**11.1**	**10.5**	**6.6**	**6.8**	**3.3**
Carbonate (shaley; clayey; silty, clayey)	0.1	0.6	3.3	4.5	0	0	4.3	1.8	0	0	1.1	0.2
Carbonate (ochreous, sandy, ochreous)	0	0	0	0	0	0	0	0	0	0	0	0
Siltstone	0	0	0	0	0	0	0	0	0	0	0	0
Total Poor Aggregate (%)	**0.1**	**0.6**	**3.3**	**4.5**	**0**	**0**	**4.3**	**1.8**	**0**	**0**	**1.1**	**0.2**
Shale	0.1	0.1	0	0	0	0	0.5	0.8	0	0	0	0
Total Deleterious Aggregate (%)	**0.1**	**0.1**	**0**	**0**	**0**	**0**	**0.5**	**0.8**	**0**	**0**	**0**	**0**
Petrographic Number (Concrete)	**104**	**110**	**132**	**126**	**111**	**111**	**157**	**138**	**121**	**113**	**119**	**108**

Results of Coarse Aggregate Petrographic Correlation Study
2001 Interlaboratory Testing Program
Stockpile Samples (Full Fraction)

Laboratory Number	**35**	**35**	**37**	**37**	**38**	**38**	**39**	**39**	**44**	**44**	**47**	**47**
Sample Number	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Carbonate (hard; silty, hard)	18.2	17.2	62.6	43	95.1	92.8	43.1	44.3	89	89.7	83.2	87.9
Carbonate ((silty,) surf. weath., (silty,) med. hard)	74	75.1	31.7	53.4	0	0	46.1	48.3	8.8	8.6	13.1	6.2
Carbonate (sandy, hard or medium hard)	3.6	3.8	0	0	0	0	0	0	0	0	0	0
Carbonate (slightly cherty: <5% chert)	0	0	0	0	0	0	0	0	0.7	0	0	0
Marble (hard or medium hard)	0	0	0	0	0	0	0	0	0	0	0	0
Conglomerate-Sandstone-Arkose (hard)	0	0	0	0	0	0	0	0	0	0	0	0
Conglomerate-Sandstone-Arkose (medium hard)	0	0	0	0	0	0	0	0	0	0	0	0
Greywacke-Argillite (hard or medium hard)	0	0	0	0	0	0	0	0	0	0	0	0
Gneiss-Amphibolite-Schist (hard)	0	0	0	0	0	0	0	0	0	0	0	0
Granite-Diorite-Gabbro (hard)	0	0	0	0	0	0	0	0	0	0	0	0
Total Good Aggregate (%)	**95.8**	**96.1**	**94.3**	**96.4**	**95.1**	**92.8**	**89.2**	**92.6**	**98.5**	**98.3**	**96.3**	**94.1**
Carbonate (soft; silty, soft; slightly shaley)	3.7	2.8	1.9	0.1	0	6.5	0	0	0.6	1	3.7	4.6
Carbonate (soft, pitted)	0	0.6	3.5	3.5	4.9	0	10.6	7.2	0.9	0.7	0	0
Carbonate (deeply weath.; silty, deeply weath.)	0	0	0	0	0	0	0	0	0	0	0	0.6
Carbonate (sandy, soft)	0.5	0.2	0	0	0	0	0	0	0	0	0	0
Chert-Cherty Carbonate (<20% leached chert)	0	0.1	0	0	0	0	0	0	0	0	0	0
Conglomerate-Sandstone-Arkose (brittle)	0	0	0	0	0	0	0	0	0	0	0	0
Greywacke (brittle)	0	0	0	0	0	0	0	0	0	0	0	0
Encrustation	0	0	0	0	0	0	0	0	0	0	0	0
Gneiss-Amphibolite-Schist (brittle)	0	0	0	0	0	0	0	0	0	0	0	0
Argillite (medium soft)	0	0	0	0	0	0	0	0	0	0	0	0
Total Fair Aggregate (%)	**4.2**	**3.7**	**5.4**	**3.6**	**4.9**	**6.5**	**10.6**	**7.2**	**1.5**	**1.7**	**3.7**	**5.2**
Carbonate (shaley, clayey, silty, clayey)	0	0.2	0.3	0	0	0	0.2	0.2	0	0	0	0.7
Carbonate (ochreous; sandy, ochreous)	0	0	0	0	0	0	0	0	0	0	0	0
Siltstone	0	0	0	0	0	0.7	0	0	0	0	0	0
Total Poor Aggregate (%)	**0**	**0.2**	**0.3**	**0**	**0**	**0.7**	**0.2**	**0.2**	**0**	**0**	**0**	**0.7**
Shale	0	0	0	0	0	0	0	0	0	0	0	0
Total Deleterious Aggregate (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Petrographic Number (Concrete)	**108**	**108**	**112**	**107**	**110**	**117**	**122**	**115**	**103**	**103**	**107**	**114**

Results of Coarse Aggregate Petrographic Correlation Study
2001 Interlaboratory Testing Program
Stockpile Samples (Full Fraction)

Laboratory Number	**59**	**59**	**61**	**61**	**71**	**71**	**72**	**72**	**80**	**80**	**84**	**84**
Sample Number	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Carbonate (hard; silty, hard)	89.4	89	83.9	80.8	35.7	10.3	40.4	84.6	89.5	81.6	84.6	88.1
Carbonate ((silty,) surf. weath.; (silty,) med. hard)	6.7	8.2	1.6	2.4	55.6	58.2	38.3	8.8	6.4	13.6	11.2	6.9
Carbonate (sandy, hard or medium hard)	1.9	0	6.3	7.3	4.4	27.8	0	1.1	0.2	0.8	1.2	1.6
Carbonate (slightly cherty: <5% chert)	0	0.6	0	0	1.5	0.6	19.4	4.7	0	0	0	0
Marble (hard or medium hard)	0	0	0	0	0	0	0	0	0	0	0	0
Conglomerate-Sandstone-Arkose (hard)	0	0	2.9	2.1	0	0	0.6	0.2	0	0.6	0	0
Conglomerate-Sandstone-Arkose (medium hard)	0	0	0	0	0	0	0	0	0	0	0	0
Greywacke-Argillite (hard or medium hard)	0	0	0	0	0	1.5	0	0	0	0	0	0
Gneiss-Amphibolite-Schist (hard)	0	0	0	0	0	0	0	0	0	0	0	0
Granite-Diorite-Gabbro (hard)	0	0	0	0	0	0.4	1.3	0.6	0	0	0	0
Total Good Aggregate (%)	**98**	**97.8**	**94.7**	**92.6**	**97.2**	**98.8**	**100**	**100**	**96.1**	**96.6**	**97**	**96.6**
Carbonate (soft; silty, soft; slightly shaley)	1.2	2.1	0.5	1.8	2.8	1.2	0	0	2.8	2.7	2.5	2
Carbonate (soft, pitted)	0	0	3	2.6	0	0	0	0	0	0	0	0.4
Carbonate (deeply weath.; silty, deeply weath.)	0	0	0.2	0.8	0	0	0	0	0	0.3	0.2	0.2
Carbonate (sandy, soft)	0	0	0	0	0	0	0	0	0	0	0	0
Chert-Cherty Carbonate (<20% leached chert)	0.8	0	0	0	0	0	0	0	0	0	0	0
Conglomerate-Sandstone-Arkose (brittle)	0	0	0	0	0	0	0	0	0	0	0	0
Greywacke (brittle)	0	0	0	0	0	0	0	0	0	0	0	0
Encrustation	0	0	0	0	0	0	0	0	0	0	0	0
Gneiss-Amphibolite-Schist (brittle)	0	0	0	0	0	0	0	0	0	0	0	0
Argillite (medium soft)	0	0	0	0	0	0	0	0	0	0	0	0
Total Fair Aggregate (%)	**2**	**2.1**	**3.7**	**5.2**	**2.8**	**1.2**	**0**	**0**	**2.8**	**3**	**2.7**	**2.6**
Carbonate (shaley; clayey; silty, clayey)	0	0.1	1.6	2.2	0	0	0	0	1.1	0.4	0.3	0.8
Carbonate (ochreous; sandy, ochreous)	0	0	0	0	0	0	0	0	0	0	0	0
Siltstone	0	0	0	0	0	0	0	0	0	0	0	0
Total Poor Aggregate (%)	**0**	**0.1**	**1.6**	**2.2**	**0**	**0**	**0**	**0**	**1.1**	**0.4**	**0.3**	**0.8**
Shale	0	0	0	0	0	0	0	0	0	0	0	0
Total Deleterious Aggregate (%)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Petrographic Number (Concrete)	**104**	**105**	**115**	**121**	**106**	**102**	**100**	**100**	**111**	**108**	**107**	**109**

Results of Coarse Aggregate Petrographic Correlation Study
2001 Interlaboratory Testing Program
Stockpile Samples (Full Fraction)

Laboratory Number	**98**	**98**	**100**	**100**	**101**	**101**	**112**	**112**	**150**	**150**	**162**	**162**
Sample Number	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Carbonate (hard; silty, hard)	85.2	92.2	0	0	98.2	98.3	39.2	93.2	64.2	61.7	73.5	75.3
Carbonate ((silty,) surf. weath.; (silty,) med. hard)	11.9	7.3	0	0	0	0.6	7.7	0	32	34.4	20.2	18.1
Carbonate (sandy, hard or medium hard)	0	0	95.6	93.1	0.8	0	0	0	0.7	1.1	0	0
Carbonate (slightly cherty; <5% chert)	0.6	0	0	0	0	0	0	0	0	0	0	0
Marble (hard or medium hard)	0	0	0	0	0	0	0	0	0	0	0	0
Conglomerate-Sandstone-Arkose (hard)	0	0	0	0	0	0	0	0	0	0	0	0
Conglomerate-Sandstone-Arkose (medium hard)	0	0	1	0	0	0	0	0	0	0	0	0
Greywacke-Argillite (hard or medium hard)	0	0	0	0	0	0	0	0	0	0	0	0
Gneiss-Amphibolite-Schist (hard)	0	0	0	0	0	0	0	0	0	0	0	0
Granite-Diorite-Gabbro (hard)	0	0	0	0	0	0	0	0	0	0	0	0
Total Good Aggregate (%)	**97.7**	**99.5**	**96.6**	**93.1**	**99**	**98.9**	**96.9**	**93.2**	**96.9**	**97.2**	**93.7**	**93.4**
Carbonate (soft, silty, soft, slightly shaley)	2.3	0.4	0	0	0.3	0.4	1	3.4	2.7	1.9	5.7	5.5
Carbonate (soft, pitted)	0	0	0	0	0	0	0.2	2.3	0.2	0.9	0	0.6
Carbonate (deeply weath.; silty, deeply weath.)	0	0	0	0	0	0	0	0	0	0	0	0
Carbonate (sandy, soft)	0	0	3.4	6.9	0	0	0	0	0	0	0	0
Chert-Cherty Carbonate (<20% leached chert)	0	0	0	0	0.7	0	0	0	0.2	0	0	0
Conglomerate-Sandstone-Arkose (brittle)	0	0	0	0	0	0	0	0	0	0	0	0
Greywacke (brittle)	0	0	0	0	0	0	0	0	0	0	0	0
Encrustation	0	0	0	0	0	0	0	0	0	0	0	0
Gneiss-Amphibolite-Schist (brittle)	0	0	0	0	0	0	0	0	0	0	0	0
Argillite (medium soft)	0	0	0	0	0	0	0	0	0	0	0	0
Total Fair Aggregate (%)	**2.3**	**0.4**	**3.4**	**6.9**	**1**	**0.4**	**1.2**	**5.7**	**3.1**	**2.8**	**5.7**	**6.1**
Carbonate (shaley, clayey; silty, clayey)	0	0	0	0	0	0.5	0.7	0.7	0	0	0.6	0.5
Carbonate (ochreous, sandy, ochreous)	0	0	0	0	0	0	0	0	0	0	0	0
Siltstone	0	0	0	0	0	0	0	0	0	0	0	0
Total Poor Aggregate (%)	**0**	**0**	**0**	**0**	**0**	**0.5**	**0.7**	**0.7**	**0**	**0**	**0.6**	**0.5**
Shale	0	0.1	0	0	0	0.2	1.2	0.4	0	0	0	0
Total Deleterious Aggregate (%)	**0**	**0.1**	**0**	**0**	**0**	**0.2**	**1.2**	**0.4**	**0**	**0**	**0**	**0**
Petrographic Number (Concrete)	**105**	**102**	**107**	**114**	**102**	**105**	**117**	**119**	**106**	**106**	**114**	**115**

Results of Coarse Aggregate Petrographic Correlation Study
2001 Interlaboratory Testing Program
Stockpile Samples (Full Fraction)

Laboratory Number	**172**	**172**	**175**	**175**	**188**	**188**	**196**	**196**	**203**	**203**	**260**	**260**
Sample Number	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Carbonate (hard; silty, hard)	85.4	88.8	17.2	21.2	35.1	33.3	84.1	88.2	98.2	97.2	57.8	56.7
Carbonate ((silty,) surf. weath.; (silty,) med. hard)	7	4.5	26.3	22.6	53.6	52.6	11.4	6.8	0	0	37.1	40.5
Carbonate (sandy, hard or medium hard)	0	0	51.5	50.5	1.8	1.1	1	1.4	1.2	1.3	0	0
Carbonate (slightly cherty: <5% chert)	0	0	0	0	0	0	0.4	0.2	0	0	0	0
Marble (hard or medium hard)	0	0	0	0	0	0	0	0	0	0	0	0
Conglomerate-Sandstone-Arkose (hard)	0	0	0	0	0	0	0	0	0	0	0	0
Conglomerate-Sandstone-Arkose (medium hard)	0	0	0	1.5	0	0	0	0	0	0	0	0
Greywacke-Argillite (hard or medium hard)	0	0	0	0	0	0	0	0	0	0	0	0
Gneiss-Amphibolite-Schist (hard)	0	0	0	0	0	0	0	0	0	0	0	0
Granite-Diorite-Gabbro (hard)	0	0	0	0	0	0	0	0	0	0	0	0
Total Good Aggregate (%)	**92.4**	**93.3**	**95**	**95.8**	**90.5**	**87**	**96.9**	**96.6**	**99.4**	**98.5**	**94.9**	**97.2**
Carbonate (soft; silty, soft; slightly shaley)	5.2	5.9	4	3.8	7.9	9.6	2.4	2.1	0.4	1	5.1	2.8
Carbonate (soft, pitted)	0	0	0	0	0	1	0	0.4	0	0	0	0
Carbonate (deeply weath.; silty, deeply weath.)	0	0	0	0	0	0	0.2	0	0	0	0	0
Carbonate (sandy, soft)	0	0	0	0	0	0	0	0	0	0	0	0
Chert-Cherty Carbonate (<20% leached chert)	0	0	0	0	0	0	0.2	0.2	0.2	0	0	0
Conglomerate-Sandstone-Arkose (brittle)	0	0	0	0	0	0	0	0	0	0	0	0
Greywacke (brittle)	0	0	0	0	0	0	0	0	0	0	0	0
Encrustation	0	0	0	0	0	0	0	0	0	0	0	0
Gneiss-Amphibolite-Schist (brittle)	0	0	0	0	0	0	0	0	0	0	0	0
Argillite (medium soft)	0	0	0	0	0	0	0	0	0	0	0	0
Total Fair Aggregate (%)	**5.2**	**5.9**	**4**	**3.8**	**7.9**	**10.6**	**2.8**	**2.7**	**0.6**	**1**	**5.1**	**2.8**
Carbonate (shaley, clayey; silty, clayey)	1.5	0.3	0.7	0.4	0.5	1.7	0.3	0.7	0	0.5	0	0
Carbonate (ochreous, sandy, ochreous)	0	0	0.3	0	0	0	0	0	0	0	0	0
Siltstone	0	0	0	0	0	0	0	0	0	0	0	0
Total Poor Aggregate (%)	**1.5**	**0.3**	**1**	**0.4**	**0.5**	**1.7**	**0.3**	**0.7**	**0**	**0.5**	**0**	**0**
Shale	0.9	0.5	0	0	1.1	0.7	0	0	0	0	0	0
Total Deleterious Aggregate (%)	**0.9**	**0.5**	**0**	**0**	**1.1**	**0.7**	**0**	**0**	**0**	**0**	**0**	**0**
Petrographic Number (Concrete)	**126**	**118**	**113**	**110**	**128**	**136**	**107**	**109**	**101**	**105**	**110**	**106**

Results of Coarse Aggregate Petrographic Correlation Study
2001 Interlaboratory Testing Program
Stockpile Samples (Full Fraction)

Laboratory Number	**295**	**295**	**301**	**301**
Sample Number	**1**	**2**	**1**	**2**
Carbonate (hard, silty, hard)	0	0	57.7	38.7
Carbonate ((silty,) surf. weath., (silty,) med. hard)	96.2	97.5	36.4	54.1
Carbonate (sandy, hard or medium hard)	0.9	0.3	0	0
Carbonate (slightly cherty, <5% chert)	0	0	0	0
Marble (hard or medium hard)	0	0	0	0
Conglomerate-Sandstone-Arkose (hard)	0	0	0	0
Conglomerate-Sandstone-Arkose (medium hard)	0	0	0	0
Greywacke-Argillite (hard or medium hard)	0	0	0	0
Gneiss-Amphibolite-Schist (hard)	0	0	0	0
Granite-Diorite-Gabbro (hard)	0	0	0	0
Total Good Aggregate (%)	**97.1**	**97.8**	**94.1**	**92.8**
Carbonate (soft, silty, soft, slightly shaley)	2.5	1.9	5.9	7.2
Carbonate (soft, pitted)	0	0	0	0
Carbonate (deeply weath., silty, deeply weath.)	0	0	0	0
Carbonate (sandy, soft)	0	0	0	0
Chert-Cherty Carbonate (<20% leached chert)	0	0	0	0
Conglomerate-Sandstone-Arkose (brittle)	0	0	0	0
Greywacke (brittle)	0	0	0	0
Encrustation	0	0	0	0
Gneiss-Amphibolite-Schist (brittle)	0	0	0	0
Argillite (medium soft)	0	0	0	0
Total Fair Aggregate (%)	**2.5**	**1.9**	**5.9**	**7.2**
Carbonate (shaley, clayey, silty, clayey)	0	0	0	0
Carbonate (ochreous, sandy, ochreous)	0	0	0	0
Siltstone	0	0	0	0
Total Poor Aggregate (%)	**0**	**0**	**0**	**0**
Shale	0.4	0.3	0	0
Total Deleterious Aggregate (%)	**0.4**	**0.3**	**0**	**0**
Petrographic Number (Concrete)	**109**	**107**	**112**	**114**

Results of Fine Aggregate Petrographic Correlation Study
2001 Interlaboratory Testing Program
Stockpile Samples

Laboratory Number	**37**	**37**	**47**	**47**	**101**	**101**	**150**	**150**	**188**	**188**	**196**	**196**	**203**	**203**	**295**	**295**
Sample Number	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Silicate (4.75-2.36 mm)	20	45.6	24	19	14.6	11.3	23.5	21.4	7.7	9.2	20	20	12.5	12.7	16.9	15.3
Silicate (2.36-1.18 mm)	19.5	35.2	24	19	19.9	23.8	23.5	21.4	18.5	18	20	20	18	20.1	20.2	15.8
Silicate (1.18-0.600 mm)	58	59.5	24.5	34	26.5	23.3	27	33.7	21.5	22.5	29	24	28.1	22.5	36.5	33.2
Silicate (0.600-0.300 mm)	77.5	78.5	52.5	54	47	59.2	57.1	57.1	41.5	45	34.5	26.5	52.2	46.1	53.1	65.3
Silicate (0.300-0.150 mm)	90	88.1	67	60.5	70.8	65	77.4	75.3	57	62.5	65.5	59	71.2	69.8	75	73.9
Silicate (0.150-0.075 mm)	94.5	82.6	64	58.5	69.6	75.6	79.6	75.6	61	64	74.5	75	69.6	67.3	74.2	79.3
Silicate (average) (%)	**59.9**	**64.9**	**42.6**	**40.8**	**41.4**	**43**	**48**	**47.4**	**34.5**	**36.9**	**40.6**	**37.4**	**41.9**	**39.7**	**45.9**	**47.1**
Carbonate (4.75-2.36 mm)	79	51.5	14.5	13.5	7.3	19.8	19	20.7	41.5	36.8	33	29	21.9	19	15.3	16.9
Carbonate (2.36-1.18 mm)	79	61.2	14.5	13.5	18.1	21.6	19	20.7	34	32	33	29	25	15.4	23.7	25.8
Carbonate (1.18-0.600 mm)	39.5	35.1	21.5	19.5	29.3	28.2	22.8	22.9	49	41.5	24	21.5	25.1	30.6	27.5	27.7
Carbonate (0.600-0.300 mm)	20.5	17.1	27.5	23	36.7	24.9	26.7	22.8	35.5	38.5	20	24	29.9	35.1	34.8	25.8
Carbonate (0.300-0.150 mm)	9	10.5	22.5	26.5	24.4	28.6	16.4	18.3	35	28.5	15	14	21.5	23.1	19.4	17.4
Carbonate (0.150-0.075 mm)	5.5	13.9	26.5	27.5	25.4	22.4	10.2	11.7	37	34	12.5	11	22.4	26.3	17.2	13.1
Carbonate (average) (%)	**38.8**	**31.6**	**21.2**	**20.6**	**23.5**	**24.3**	**19**	**19.5**	**38.7**	**35.2**	**22.9**	**21.4**	**24.3**	**24.9**	**23**	**21.1**
Shale (4.75-2.36 mm)	0	0	57.5	61	67.1	65.1	52.4	52.9	47.7	49.4	42.5	45	62.5	61.3	64.4	66.1
Shale (2.36-1.18 mm)	0	0	57.5	61	57.1	50.7	52.4	52.9	43	45	42.5	45	54.2	58.9	54.4	55.5
Shale (1.18-0.600 mm)	0	0	51.5	43	36.8	43.2	43.7	37.8	25	31.5	42.5	48.5	42.4	42.1	35.5	37.9
Shale (0.600-0.300 mm)	0	0	18.5	20	13.5	14.9	14.9	17.5	21	14	40.5	44	16.4	17.8	11.6	8
Shale (0.300-0.150 mm)	0	0	7.5	10.5	4.3	6	5.8	5.9	6	6.5	15	21	5.9	6.6	3.9	5.7
Shale (0.150-0.075 mm)	0	0	5	9.5	3	1.5	7.3	8.3	1.5	1.5	8	8	6.6	4.6	3.8	3.5
Shale (average) (%)	**0**	**0**	**32.9**	**34.2**	**30.3**	**30.2**	**29.4**	**29.2**	**24**	**24.6**	**31.8**	**35.2**	**31.3**	**31.9**	**28.9**	**29.5**
Mica (4.75-2.36 mm)	0	0	0	0	1.2	0	0	0	0	0	0.5	1	0	0	0	0
Mica (2.36-1.18 mm)	0	0	0	0	0	0	0	0	0	0	0.5	1	0	0	0	0
Mica (1.18-0.600 mm)	0	0	0	0	0	0	0	0	0	0	2.5	2.5	0	0	0	0
Mica (0.600-0.300 mm)	0	0	0.5	0.5	0	0	0.3	0.4	0	0	3.5	3.5	0	0	0.5	0.9
Mica (0.300-0.150 mm)	0	0	2	1	0.5	0.4	0	0	0	0.5	4	5	0	0	1.7	3
Mica (0.150-0.075 mm)	0	0	4.5	4.5	2	0.5	2.4	3.4	0.5	0.5	5	6	0.9	1.8	4.8	4.1
Mica (average) (%)	**0**	**0**	**1.2**	**1**	**0.6**	**0.2**	**0.5**	**0.7**	**0.1**	**0.2**	**2.7**	**3.2**	**0.2**	**0.3**	**1.2**	**1.3**
Chert (4.75-2.36 mm)	1	2.9	4	6.5	8.6	3.8	5.1	5	3.1	4.6	4	5	3.1	7	3	1.7
Chert (2.36-1.18 mm)	1	3.6	4	6.5	4.9	3.9	5.1	5	4.5	5	4	5	2.8	5.6	1.7	2.9
Chert (1.18-0.600 mm)	2	4.4	2.5	3.5	7.4	5.3	6.5	5.6	4.5	4.5	2	3.5	4.4	4.8	0.5	1.2
Chert (0.600-0.300 mm)	1	3.4	1	2.5	2.8	1	1	2.2	2	2.5	1.5	2	1.5	1	0	0
Chert (0.300-0.150 mm)	0.5	0.9	1	1.5	0	0	0.4	0.5	2	2	0.5	1	1.4	0.5	0	0
Chert (0.150-0.075 mm)	0	3	0	0	0	0	0.5	1	0	0	0	0	0.5	0	0	0
Chert (average) (%)	**0.9**	**3**	**2.1**	**3.4**	**4**	**2.3**	**3.1**	**3.2**	**2.7**	**3.1**	**2**	**2.8**	**2.3**	**3.2**	**0.9**	**1**
Contamination (4.75-2.36 mm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Contamination (2.36-1.18 mm)	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Contamination (1.18-0.600 mm)	0.5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Contamination (0.600-0.300 mm)	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Contamination (0.300-0.150 mm)	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Contamination (0.150-0.075 mm)	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Contamination (average) (%)	**0.4**	**0.5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Cementation (4.75-2.36 mm)	0	0	0	0	1.2	0	0	0	0	0	0	0	0	0	0.4	0
Cementation (2.36-1.18 mm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cementation (1.18-0.600 mm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cementation (0.600-0.300 mm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cementation (0.300-0.150 mm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cementation (0.150-0.075 mm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cementation (average) (%)	**0**	**0**	**0**	**0**	**0.2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.1**	**0**

Laboratory Ratings Data

PRODUCTION LABORATORY RATINGS 2001

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-607 % Crushed Particles	LS-621 % Asphalt Coated	LS-608 % Flat & Elongated	Rating
1	5	15.0	9	9	10	69
3	3	21.8	8	6	10	70
10	0	28.1	2	9		65
12	10	28.1	10	10	5	90
13	6	20.7	6	10	9	74
15	10	22.4	9	4	9	78
16	9	16.1	10	7	0	60
17	8	25.6	10	10		89
18	10	25.9	9	7	10	88
19	10	29.2	0	7	10	80
20	10	28.4	10	10		97
21	10	28.4	0	10		81
22	5	20.7	6	10	7	70
23	7	28.4	6	9	10	86
26	8	27.5	7	9	10	88
28	10	28.4	10	10	10	98
29	7	28.1	10	9		90
31	9	29.7	6	10	10	92
32	10	28.9	9	10	9	96
33	9	28.4	9	5	10	88
34	10	20.7	0	10	3	62
35	7	28.9	10	10	10	94
36	10	18.0	0	0		47
37	9	29.5	9	10	10	96
38	10	29.5	10	10		99
39	8	28.4	10	10	10	95
44	10	21.8	10	10	5	81
45	0	28.1	10	5	9	74
46	10	22.4	9	10	10	88
47	10	27.5	8	9	9	91
54	5	28.9	10	9	10	90
55	10	25.4	0	6	7	69
56	8	28.9	9	10	10	94
58	10	27.8	10	9	6	90
59	10	25.9	5	10	10	87
61	9	28.1	10	10	8	93
64	10	26.2	10	10	9	93
66	1	29.2	10	9	3	75
67	10	28.1	10	10		97
68	10	29.2	9	9	10	96
69	10	26.7	4	10	10	87

PRODUCTION LABORATORY RATINGS 2001

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-607 % Crushed Particles	LS-621 % Asphalt Coated	LS-608 % Flat & Elongated	Rating
71	8	29.5	10	8	7	**89**
72	9	30.0	9	10		**97**
73	9	23.5	10	6		**81**
79	10	30.0	10	9	10	**99**
80	9	27.0	10	7	9	**89**
81	0	20.7	7	10	6	**62**
83	10	28.1	10	10	3	**87**
84	8	25.4	10	10	9	**89**
86	9	29.7	10	8	10	**95**
90	10	28.1	9	9	3	**84**
98	10	28.1	10	8	9	**93**
100	10	28.6	10	2	10	**87**
101	9	28.9	9	9	10	**94**
102	8	13.1	9	3		**55**
103	10	29.5	10	10	10	**99**
104	8	28.9	10	2	10	**84**
105	0	28.1	9	9	0	**66**
107	10	24.5	0	10	10	**78**
108	10	28.9	0	9	10	**83**
110	8	26.2	10	2	10	**80**
112	5	27.8	7	10	10	**85**
113	10	27.3	9	10	10	**95**
114	10	26.5	10	10	10	**95**
115	10	27.3	10	10	10	**96**
116	10	28.6	10	9	10	**97**
117	2	27.3	8	9	10	**80**
118	10	27.8	10	10	10	**97**
120	10	27.0	9	10	8	**91**
121	10	27.5	10	10	8	**94**
123	10	18.8	10	10	3	**74**
124	9	30.0	10	2	10	**87**
126	2	28.6	0	8		**64**
127	10	27.0	5	10		**87**
128	10	21.8	10	10		**86**
129	8	25.4	3	9		**76**
132	10	25.9	10	9		**92**
134	0	12.0	9	10	10	**59**
135	10	30.0	8	10	10	**97**
136	7	29.5	10	5	8	**85**
137	8	29.7	10	10	10	**97**
138	8	23.2	10	10	10	**87**

PRODUCTION LABORATORY RATINGS 2001

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-607 % Crushed Particles	LS-621 % Asphalt Coated	LS-608 % Flat & Elongated	Rating
139	0	17.2	7	8	10	**60**
140	10	30.0	7	10	9	**94**
141	6	26.5	8	2	10	**75**
142	6	30.0	10	2	10	**83**
144	10	23.5	10	10	10	**91**
146	8	20.2	8	9	10	**79**
147	10	14.7	7	10	4	**65**
148	0	27.5	7	10	10	**78**
149	10	24.5	10	8	10	**89**
153	3	24.8	8	9	10	**78**
156	0	27.3	10	6	9	**75**
157	10	27.3	10	10	10	**96**
160	8	21.5	10	10	10	**85**
161	4	25.4	5	10	10	**78**
162	9	27.5	10	10	10	**95**
163	10	25.9	6	0	10	**74**
164	10	26.2	7	10	10	**90**
167	10	22.9	8	10	10	**87**
170	9	27.0	4	10		**83**
171	8	28.1	7	10		**88**
172	10	19.6	5	8	10	**75**
175	10	28.6	0	8	10	**81**
176	10	29.7	0	10		**83**
177	10	27.8	10	10	10	**97**
178	6	21.8	0	9	7	**63**
179	0	15.5	4	10	3	**46**
180	0	28.6	6	10	10	**78**
181	10	25.4	0	6	8	**71**
182	7	17.5	0	8	6	**55**
184	9	24.8	9	7	9	**84**
186	10	25.9	10	7		**88**
187	2	26.5	9	10	6	**76**
188	9	29.2	10	9	10	**96**
189	6	25.9	8	8	9	**81**
191	7	29.7	0	10	10	**81**
193	10	26.2	10	10	10	**95**
194	0	28.4	0	10	9	**68**
197	9	29.7	10	10		**98**
198	0	27.5	9	10	8	**78**
199	9	30.0	10	10	10	**99**
200	2	28.9	10	9	7	**81**

PRODUCTION LABORATORY RATINGS 2001

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-607 % Crushed Particles	LS-621 % Asphalt Coated	LS-608 % Flat & Elongated	Rating
201	10	25.1	0	9		**73**
202	9	24.0	0	9		**70**
204	10	27.0	10	10	10	**96**
205	10	25.9	10	10	9	**93**
208	10	30.0	4	10	2	**80**
209	10	25.1	10	6	10	**87**
212	0	28.1	10	9	10	**82**
215	5	29.5	10	7	8	**85**
216	10	25.9	10	10	10	**94**
217	9	24.8	10	8		**86**
218	9	27.8	10	10	10	**95**
219	10	27.8	7	3	10	**83**
221	9	29.2	10	10	10	**97**
223	10	24.0	8	10		**87**
224	8	28.4	10	10	9	**93**
226	7	28.6	10	10	10	**94**
228	10	22.4	10	10		**87**
230	8	27.3	10	10		**92**
231	10	28.4	10	8		**94**
232	0	29.2	0	7	6	**60**
233	10	27.5	10	9		**94**
235	0	29.5	0	7	6	**61**
236	10	30.0	10	10	0	**86**
242	6	29.2	10	5		**84**
244	5	29.5	10	10		**91**
245	10	28.4	10	10	9	**96**
246	10	27.8	10	9	10	**95**
247	9	28.6	7	10	10	**92**
248	10	28.6	6	10		**91**
249	7	24.3	9	10		**84**
250	10	30.0	10	9		**98**
251	8	30.0	10	10	0	**83**
253	0	28.1	8	9	10	**79**
254	10	26.5	9	5	10	**86**
255	10	26.2	10	10		**94**
256	9	24.3	10	10	8	**88**
257	9	28.6	10	10		**96**
259	10	29.5	8	10	0	**82**
260	10	21.8	10	8	10	**85**
262	7	19.1	10	9	0	**64**
263	10	15.5	10	10	7	**75**

PRODUCTION LABORATORY RATINGS 2001

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-607 % Crushed Particles	LS-621 % Asphalt Coated	LS-608 % Flat & Elongated	Rating
264	10	30.0	10	9	7	**94**
269	10	27.8	9	10		**95**
271	8	25.4	10	10	0	**76**
272	10	25.6	6	10	5	**81**
273	10	22.9	0	6	7	**66**
274	10	28.6	10	10	10	**98**
275	10	28.6	9	9	10	**95**
276	10	27.0	10	9	10	**94**
277	0	28.9	10	8	10	**81**
279	9	29.7	7	8	10	**91**
280	9	29.7	2	7	8	**80**
281	10	14.7	10	8		**71**
283	9	24.8	10	10	10	**91**
284	8	24.8	10	10	8	**87**
285	10	22.6	10	9	8	**85**
287	9	28.9	5	4		**78**
288	8	27.8	0	4	8	**68**
289	10	27.5	0	10	10	**82**
290	10	21.3	7	10	8	**80**
291	7	24.5	9	10	0	**72**
292	10	22.6	10	9	10	**88**
293	10	29.7	10	5		**91**
294	9	25.9	10	10	7	**88**
295	7	26.7	10	10	8	**88**
296	9	24.0	9	3		**75**
297	8	20.5	10	10	10	**84**
298	8	29.5	10	10		**96**
299	10	27.8	10	10	9	**95**
301	2	27.8	9	8	10	**81**
302	2	29.7	10	10		**86**
303	9	26.7	7	10	10	**90**
304	4	26.2	10	10		**84**
305	0	21.0	5	9		**58**
306	9	28.9	8	10	9	**93**

FULL SERVICE AGGREGATE LABORATORY RATINGS 2001

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-603 LAA	LS-604 BRD/ABS (CA)	LS-606 $MgSO_4$ (CA)	LS-607 % Crush	LS-621 % Asphalt	LS-608 % Flat & Elongated	LS-618 MDA (CA)	LS-614 F/T	LS-605 BRD/ABS (FA)	LS-606 $MgSO_4$ (FA)	LS-623 One Point Proctor	LS-619 MDA (FA)	Rating
13	6	20.7		4	10	6	10	9	10	5	10	8	6.0	7	**74**
15	10	22.4		9	10	9	4	9	9	9	10	10	10.0	10	**88**
18	10	25.9		9.5	5	9	7	10	8	6	10	7	10.0	10	**85**
19	10	29.2	8	9		0	7	10	7	8	10		7.3	7	**80**
22	5	20.7		6.5		6	10	7	8	9	6		8.0	8	**72**
23	7	28.4		4.5	4	6	9	10	0	10	9	5	7.7	0	**67**
28	10	28.4		10		10	10	10	9	10	10		8.3	9	**96**
31	9	29.7	10	10	10	6	10	10	10	10	10	8	10.0	10	**95**
35	7	28.9	9	9.5	10	10	10	10	10	10	6	9	8.3	10	**92**
37	9	29.5		10	10	9	10	10	9	10	9.5	8	9.3	8	**94**
38	10	29.5	7	7.5	9	10	10		10	10	8	10	10.0	10	**94**
46	10	22.4		7	9	9	10	10	5	0	7.5	8	10.0	10	**79**
47	10	27.5	9	9	10	8	9	9	10	8	10	10	10.0	10	**93**
56	8	28.9	10	10	10	9	10	10	7	7	10	10	10.0	10	**94**
59	10	25.9		9	10	5	10	10	10	10	9.5	6	8.0	9	**88**
61	9	28.1		10	10	10	10	8	10	10	9.5	10	9.3	10	**96**
69	10	26.7		8.5		4	10	10	6	10	6.5		10.0	6	**83**
79	10	30.0		10		10	9	10	10	10	10		10.0	10	**99**
80	9	27.0	10	7.5	8	10	7	9	10	10	10	10	10.0	10	**92**
84	8	25.4		8.5	10	10	10	9	8	8	9.5	10	9.3	10	**90**
90	10	28.1		10	9	9	9	3	10	10	10			10	**91**
98	10	28.1	9	6		10	8	9	10	0	9		8.0	10	**84**
100	10	28.6		10	8	10	2	10	10	10	9			10	**90**
101	9	28.9	9	7	10	9	9	10	10	10	8.5	10	9.3	10	**94**
107	10	24.5		10	10	0	10	10	8	4	10	10		4	**79**
108	10	28.9		10	7	0	9	10	8		8	10	10.0	10	**86**
112	5	27.8		10	10	7	10	10	7	4	0	10	10.0	10	**81**
123	10	18.8		5	10	10	10	3	2	10	10	10	8.3	10	**78**
124	9	30.0		10		10	2	10	9	10	10		10.0	10	**92**
140	10	30.0		10	10	7	10	9	10	10	10			9	**96**

FULL SERVICE AGGREGATE LABORATORY RATINGS 2001

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-603 LAA	LS-604 BRD/ABS (CA)	LS-606 $MgSO_4$ (CA)	LS-607 % Crush	LS-621 % Asphalt	LS-608 % Flat & Elongated	LS-618 MDA (CA)	LS-614 F/T	LS-605 BRD/ABS (FA)	LS-606 $MgSO_4$ (FA)	LS-623 One Point Proctor	LS-619 MDA (FA)	Rating
144	10	23.5		10	10	10	10	10	8		10	8	9.0	10	**92**
157	10	27.3		8	10	10	10	10	10	9	10	10		10	**96**
162	9	27.5		9.5	10	10	10	10	10	6	10	10		6	**91**
164	10	26.2		5	10	7	10	10	8	0	8	7		9	**79**
172	10	19.6		10	8	5	8	10	10	10	10	1	10.0	10	**81**
188	9	29.2	10	5.5	10	10	9	10	8	9	7.5	10	9.7	7	**90**
205	10	25.9		6		10	10	9	10	9	9		9.3	10	**91**
216	10	25.9		9.5	8	10	10	10	10	9	8.5	10	6.7	9	**91**
245	10	28.4		10		10	10	9	10	10	9.5		10.0	10	**98**
260	10	21.8		10	10	10	8	10	6	10	0	10	9.7	9	**83**
263	10	15.5		10	0	10	10	7	9	9	9	0	9.3	10	**73**
285	10	22.6		4 5	9	10	9	8	10	9	10		10.0	10	**87**
295	7	26.7		9.5	9	10	10	8	10	10	9.5	10	9.7	10	**93**
301	2	27.8		8.5	6	9	8	10	9	10	0	10	6.3	10	**78**
306	9	28.9		9	10	8	10	9	0	10	10	8	1.3	9	**81**

SOIL LABORATORY RATINGS 2001

Lab No.	LS-702 Hydrometer Analysis	LS-703 & 4 Atterberg Limits	LS-705 Specific Gravity	Rating
18	10.0	10.0	10	**100**
19	0.0	10.0	9	**63**
20	9.4	9.0	10	**95**
22	8.2	10.0	8	**87**
23	8.4	8.3	10	**89**
28	9.6	9.7	9	**94**
29	8.0	5.7	10	**79**
30	6.2	9.3	8	**78**
31	5.8	10.0	10	**86**
32	9.6	10.0	9	**95**
34	8.0	9.7	10	**92**
35	7.0	10.0	0	**57**
37	10.0	10.0	10	**100**
38	0.0	9.7	10	**66**
44	9.0	9.7	8	**89**
46	0.0	9.3	0	**31**
47	10.0	9.0	3	**73**
54	9.8	8.3	10	**94**
56	8.0	8.0	10	**87**
58	10.0	10.0	10	**100**
59	10.0	8.0	10	**93**
64	0.4	5.3	0	**19**
66	0.0	9.3	0	**31**
67	8.8	8.3	7	**80**
68	9.8	9.0	8	**89**
69	10.0	10.0	10	**100**
71	8.8	9.0	10	**93**
72	10.0	10.0	8	**93**
79	9.8	9.7	10	**98**
80	10.0	9.7	9	**96**
83	5.8	9.7	10	**85**
84	10.0	10.0	8	**93**
86	9.6	10.0	8	**92**
94	10.0	9.7	4	**79**

Lab No.	LS-702 Hydrometer Analysis	LS-703 & 4 Atterberg Limits	LS-705 Specific Gravity	Rating
101	6.6	6.0	8	**69**
105	0.0	8.3	0	**28**
108	0.0	10.0	10	**67**
112	9.8	9.0	10	**96**
119	0.0	9.7	9	**62**
120	8.6	10.0	7	**85**
138	9.8	7.3	10	**90**
144	8.4	10.0	0	**61**
146	9.4	10.0	9	**95**
188	9.4	8.0	10	**91**
208	3.0	8.0	10	**70**
210	9.8	9.7	0	**65**
216	10.0	9.7	9	**96**
253	7.2	7.3	9	**78**
260	9.4	8.7	10	**94**
284	8.4	9.3	10	**92**
292	0.0	8.0	0	**27**
299	8.6	9.7	8	**88**
301	0.0	8.3	10	**61**
306	10.0	9.7	8	**92**